MODERN PLASTICS

PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER

LENSES—THE FOCUS IS ON PLASTICS *p. 90*

Better products through polyethylene coatings *p. 84*

Now you can injection mold urethane elastomers *p. 88*

How to make two-color signs without paint *p. 98*

What you must know about blow molding *p. 105*

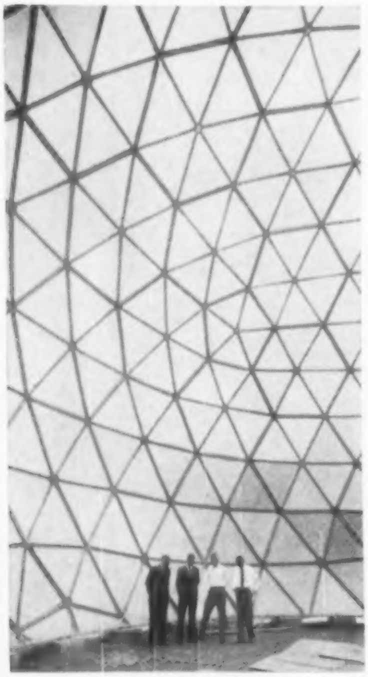
MARCH 1961

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Fire-retardant radome**
- **Plastic potentiometer**
- **Phenolic for motor housings**

Big bubble

This gigantic plastic space frame has a girth of 60 feet, and arches 45 feet overhead. It is one of twenty rigid radomes built in this country to shelter radar antennas in the NATO Early Warning Defense net.



UNIVERSAL MOULDED PRODUCTS CORP.

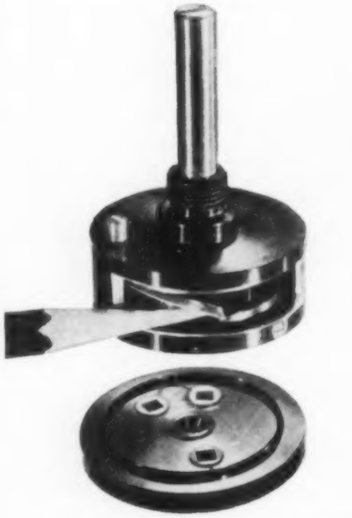
Materials for such a structure must have low dielectric constant and low loss tangent to minimize effect on electromagnetic radiation. The huge bubble must stand firm against hurricane-force winds. It must not crack when temperature plummets to −60°F. It must also retard fire.

To meet these stiff requirements, the fabricator chose Hetron,® a Durez polyester resin with inherent fire retardance. Reinforced with glass fabric and mat, 285 Hetron molded panels bolt together to form the radome.

Because its physical properties need not be diluted with additives to achieve fire retardance, Hetron resin has become the standard for demanding uses such as this one. We'll be happy to send you more information on this family of premium-quality polyesters.

Look—no coils

Get to the heart of a new and better product, and often you'll find a Durez plastic.



NEW ENGLAND INSTRUMENT COMPANY

For instance: this little precision potentiometer. It's better because it's simpler—contains no resistance wire, no varnish, no cement to come unstuck and cause failure.

Instead, the metallic wiper (at pencil point) rides on an almost friction-free plastic ring, the resistance element. The ring is made of diallyl phthalate resin mixed with carbon. The buttonlike insulating base is a standard Durez diallyl phthalate molding compound.

Potentiometers made with these materials just don't seem to wear out. Nor do they lose their excellent insulation properties in clammy surroundings. For these reasons, the little instruments are being specified widely for missile and rocket control systems, computers, and servo gear.

When your design project needs a moldable material of far-better-than-average electrical properties—*plus* resistance to moisture and heat—think of Durez diallyl phthalate molding compounds. We'll gladly send you facts about them.

Housing for life

Here is part of an appliance not built for planned obsolescence.

The new Hoover convertible vacuum cleaner, say its makers, is designed for virtually a lifetime of service. Its engineering represents over 50 years of leadership in a highly competitive field.

It's significant, then, that to enclose the cleaner's two-speed ¼-hp motor Hoover designers settled on a housing of molded Durez phenolic.

THE HOOVER COMPANY

You needn't look far to find good sound reasons for using phenolic to mount or protect a motor. Phenolic gives lifetime stamina at low cost. It's rugged, non-warping—yet weighs less than other housing materials. On a complex part, it can save you much costly machining.

Your custom molder can tell you more. Or write for complete data.

The following literature contains detailed information on the Durez products mentioned above:

Bulletin D6: properties and applications of Hetron fire-retardant resins

Data Sheets: facts about diallyl phthalate molding compounds

Bulletin D400: properties and uses of Durez phenolic molding materials

Mail your request for any or all of this material with your name, title and company address. *(When requesting samples, please use business letterhead.)*

DUREZ PLASTICS DIVISION

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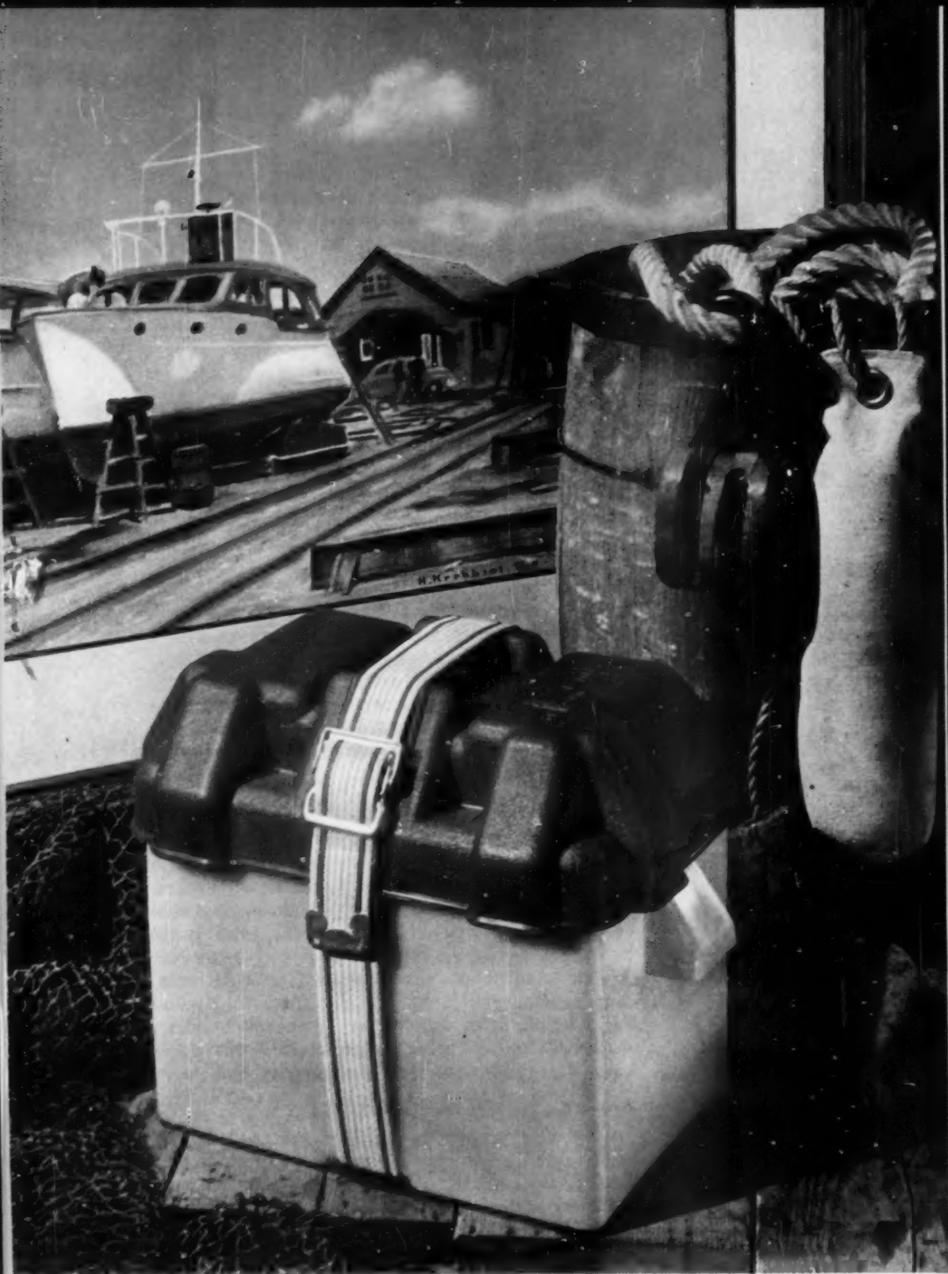
HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS



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- Medium Density
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Any old salt . . . and any sprightly young skipper of a power boat . . . knows that the battery is the nerve center of his motor. It must be protected against the hazards of rough-weather pitching and rolling, as well as unexpected bumps, causing acid spills, when it's being carried aboard or ashore . . . all the risks of assault and battery from whatever source. *Sea Guard**, by Sinko, is a rugged, lightweight case molded of unbreakable, rigid Catalin Polyethylene, impervious to battery acids, 100% weatherproof. It is supplied in sizes to hold all standard 6 and 12 volt marine batteries. Easily installed, it comes complete with hardware and a hold-down strap tested to 2000 lbs.

Available in the widest range of densities and melt indices, Catalin Polyethylene is outstandingly versatile. It is one of Catalin's comprehensive range of molding, blow molding and extrusion compounds. Inquiries invited.

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One Park Avenue, New York 16, N. Y.

MODERN PLASTICS*

Volume 38, Number 7 **March 1961**

THE PLASTISCOPE

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When "big" fellows get together (p. 39); Shell's position in plastics (p. 39); Linear PE capacity added (p. 41); New linear PE developed (p. 41); Delrin price drops again (p. 43); New formaldehyde-based copolymer (p. 45); High-temperature Geon in commercial production (p. 45).

EDITORIAL

The year of innovation **83**
Much has happened in the two and a half years since the last American plastics show. This year's show, plus others in Britain, Belgium, and Canada, will emphasize just how much . . . and will point the way to further advances.

GENERAL

Better products through polyethylene coatings **84**
Manufacturers in a wide range of industries have now at their disposal a surprisingly large spectrum of coating resin formulations and substrates. As a result, PE-coated materials, which in the past had been largely confined to the packaging market, have now penetrated other areas in large volume. To make fullest use of PE coatings in your product, you must know what densities, melt indices, and molecular weight distributions give you the properties you need. Here is a guide to what combinations of these three factors will be best for any set of requirements and what processing considerations will influence the final choice.

Urethane elastomers—new material for plastics processors **88**
Until recently, urethane elastomers could only be processed through casting or compression molding of cast sheet. As a result the entire business was handled by the rubber industry; and because of the high processing cost involved in casting systems, large market areas for which urethane's properties were extremely suitable could not be penetrated at all. Now several formulations have been developed that are processable on plastics injection-molding, extrusion, and transfer equipment. This event has two important consequences: 1) it can reduce finished parts costs by as much as 50%, 2) it opens up to the plastics industry completely new application areas.

Learn from lenses **90**
There are few fields in which the prime design advantages of plastics—better performance and/or lower costs—have been more strikingly demonstrated than in the ophthalmic and industrial lens industry. In some cases, savings to the user of plastics lenses amount to 90% of the cost of glass equivalents, while at the same time giving him a better product. Here is a run-down on the various materials and processing techniques that bring these economies and property benefits to the user, and the conclusions that can be drawn by manufacturers concerned with the production of transparent products—not necessarily optical.

Sandwiches to order **94**
Multi-purpose structures incorporated in the cabin design of the Convair 880 pioneer new concepts in the use of prepreg skins and different core materials. Involved are vinyl foam, phenolic-impregnated honeycomb, cellular cellulose acetate, and glass-reinforced epoxy. Techniques developed in producing the sandwiches, adhesives used, and performance benefits gained have significance far beyond the aviation field: automotive engineers, builders, architects, and all those concerned with the problems of structure will find intriguing ideas here.

Antenna trunks for $400 less **97**
By replacing a conventional steel unit with a filament-wound reinforced polyester housing, manufacturer was able to effect saving of $420 per installation and a weight reduction of 500 lb. per trunk. These units are now specified on all new ship construction controlled by the Maritime Administration, including the first nuclear merchant ship.

Two-color signs—without paint **98**
Now you can eliminate second-surface decorating media and still get a two-color effect in butyrate signs. The secret? A wide, continuously extruded duplex lamination consisting of two layers of differently colored film. The two-tone effect is achieved by abrading the top surface of raised designs after forming, exposing the second color.

Plastics create an architectural wonder **100**
The recently erected Seven Seas Panorama, an aquarium in Chicago's Brookfield Zoo, incorporates a number of unique plastics designs that will be of major interest to companies in the building construction field. Among the unusual features is the removable roof consisting of free blown acrylic bubbles, roof supports molded of reinforced plastics, exterior vinyl coatings, all-vinyl salt water piping system—2000 ft. of it—and others.

***Miniature moldings for electronic wristwatch* 103**
Two parts transfer molded of diallyl phthalate are put to work in a transistorized time piece to permit miniaturization necessary for this new development. Successful application in this device is expected to lead to further usage in space electronics.

***New Developments* 147**
Largest geodesic dome . . . Microminiature parts from epoxy stock . . . Integral hinge for lens case (p. 147). Nutcracker of acrylic . . . Polypropylene line strainers . . . ABS sheet housing (p. 148). Transparent insulation . . . Novel design for medical tubing . . . Packing crate of styrene foam (p. 149).

ENGINEERING

***Blow molding fundamentals* 105**
Peak performance in blow molding is usually possible only if the user gives proper consideration to the design of machine components in addition to having a full understanding of the extrusion characteristics of the thermoplastic being processed. Fundamental principles for design of machine components—extrusion heads, dies, and molds—are spelled out in detail. *By David Schmidt*

***Designing plastics parts for metallizing* 114**
The secret of best results in metallized products lies as much in the original design of that product as it does in the proper application of metallizing techniques. Here are the most important do's and don't's for designers and molders. *By Allen Shaw*

TECHNICAL

***Progress in reinforced polyesters* . . . 123**
What are the problems that need to be solved in order that reinforced polyesters can find wider and more extensive use in fields till now hardly penetrated? Areas covered include resin, reinforcements, glass-resin bond, creep and fatiguing properties and degradation. *By G. Tolley*

***Infra-red spectrum of polyethylene* . . 132**
The advantage of being able to make measurements on the polymer makes infra-red spectrophotometry especially important for the understanding of molecular structures of plastics. In the case of polyethylene it has been possible to study 1) crystallinity, 2) branching, and 3) oxidation. *By D. L. Wood and J. P. Luongo*

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Coming Up . . .

What are the prospects for ABS (acrylonitrile-butadiene-styrene)? With the number of companies in the field about to double, our April lead will report on the latest formulations, markets, and problems . . . Why plastics are growing in door hardware . . . New developments in signs and displays . . . The first U. S. refrigerator food cabinet liner, vacuum formed of styrene sheet . . . How a sophisticated floor appliance manufacturer specifies plastics . . . Engineering lead for April will cover equipment for embedment and encapsulation.

WE'RE MOVING

After March 17, the Executive and Editorial Offices of MODERN PLASTICS will be located in a new office building at 770 Lexington Ave., New York 21, where Breskin Publications will occupy two floors. In the meantime, correspondence should be directed to the present address, 575 Madison Ave., New York 22. In the new location, telephone and teletype numbers will remain the same.

Modern Plastics Executive and Editorial Offices: 575 Madison Avenue, New York 22, N.Y. Please mail all correspondence, change of address notices, subscription orders, etc., to above address. Quotations on bulk reprints of articles appearing in this issue are available on request.

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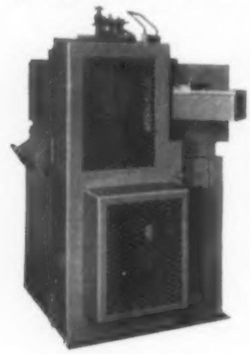
The greatest variety of plastics granulating, pelletizing and dicing machines ever offered. Machines of advanced design for every need from laboratory models to the ultimate in size and capacity.

Cumberland "Stair-Step" Dicing Machines



For dicing the *full range* of thermoplastic materials.

Cubes 1/16" to 1" produced from plastic sheet or ribbon stock. Pellet sizes altered merely by changing knives. Cubing is done in one severing operation with rotor knives cutting against one bed knife.

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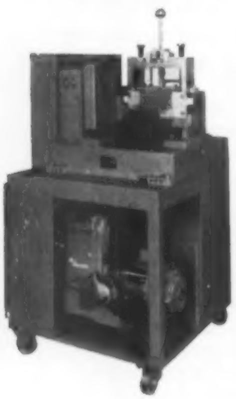
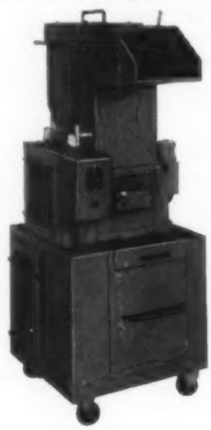


A full range of pelletizing machines with the following feed table widths: 6", 14", 17", 24", 28" and 42". Newly designed models to accommodate today's high input speeds and high hourly capacities.

Straight feed dicing machines are modified pelletizing machines known as the Cumberland Notched – Knife and Ratchet – Tooth Dicing Machines. They are less expensive though more limited in application than the Cumberland Stair-Step Dicer. These straight feed dicing machines have the same feed table widths as the pelletizers. They produce rectangles or cubes from extruded or milled sheet or ribbon stock.

Five Improved Cumberland Large Throat Granulating Machines



Large throat openings – 7"x10", 8½"x12", 8½"x16", 12"x16", 12"x20" – designed for use beside the press or for central granulating machines.

New knife design and slow rotor rpm provide better granulation, and at the same time yield quiet operation. Clean cutting is assured throughout the complete range of thermoplastic materials from softest polyethylene and vinyls to hard and tough nylon, Cycolac and Kralastic.

Quality construction, rugged as all Cumberland machines, is entirely of steel weldments. Advanced design leaves all working parts readily accessible for cleaning and adjustment of knives.

Minimum floor space. End removable screens.

Cumberland Laboratory and Pilot Plant Machines

A new 6" Pelletizer
A new 3½" Stair-Step Dicer
Granulating Machines O and 710

Cumberland New Extra Large Granulating Machines.

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Direct factory engineering assistance available throughout North America from sales offices in Providence, New York, Cleveland, Chicago and Los Angeles.

Outside North and South America — Cumberland machines are manufactured and sold by our licensee BURTONWOOD ENGINEERING COMPANY, LTD., BURTONWOOD, WARRINGTON, LANCASHIRE, ENGLAND.

269-0

Look what you can do with Geon

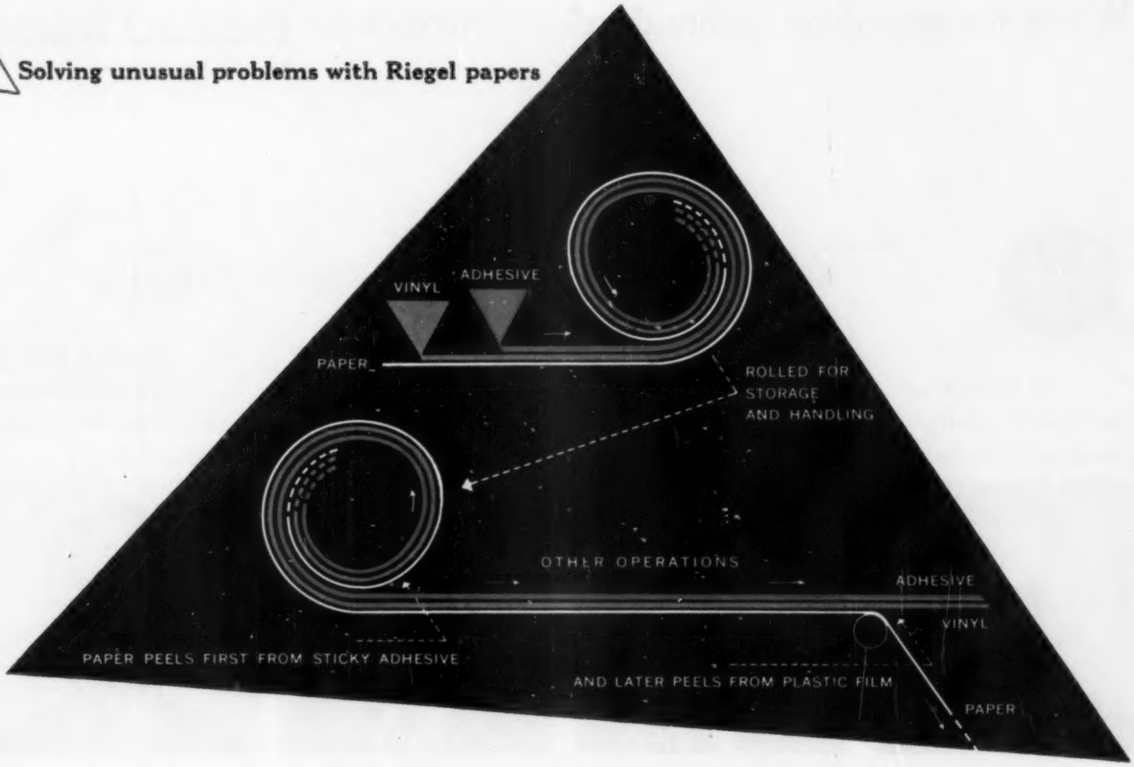
DIP IT. The maker of this water demineralizer did—discovered a low cost, simple way of getting a thick, tough, abrasion-resistant shell that is not affected by the acids and alkalies encountered in water treatment. Geon vinyl coatings can be applied many ways to many products—metals, textiles, papers, and others.

EXTRUDE IT. To obtain a wide variety of shapes and sizes with exceptional accuracy of detail, and exceptional properties. Corrosion-resistant. Abrasion-resistant. Colorful. Geon vinyl is ideal for molding, seals, tracks — comes in rigid form with spring-back properties or in softer form for sealing qualities.

ROTATIONALLY CAST IT. This horse is rotationally cast of Geon vinyl in one piece. Provides the right combination of durometer hardness, tensile strength, heat stability and low viscosity range. Best of all, use of Geon permits exceptional accuracy of detail and color, for true-to-life appearance.

FOR MORE INFORMATION ABOUT THESE and other ways you can use Geon vinyl to improve your product, or open new markets, write Dept. NF-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

Solving unusual problems with Riegel papers



Plastic Casting Paper and Release Paper...all in one!

An idea . . . and a search for a paper that didn't exist . . . recently brought a leading manufacturer to Riegel. Wanted: a paper that would serve as casting paper for plastic film and release paper for pressure-sensitive adhesive . . . *all in one!*

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The film of vinyl is continuously cast on the top of the paper and cured at temperatures over 400°F. The paper serves as a carrier while the adhesive is applied to the vinyl. The whole thing, paper, plastic, and adhesive, is then rolled for storage.

Later, when the roll is unwound, the release-coated *back* of the paper peels easily from the sticky adhesive, with such a light pull that the adhesive-coated vinyl film remains on the base paper where it was cast. Yet a few steps later, the plastic itself strips cleanly from the paper. We've named it a *differential* release paper.

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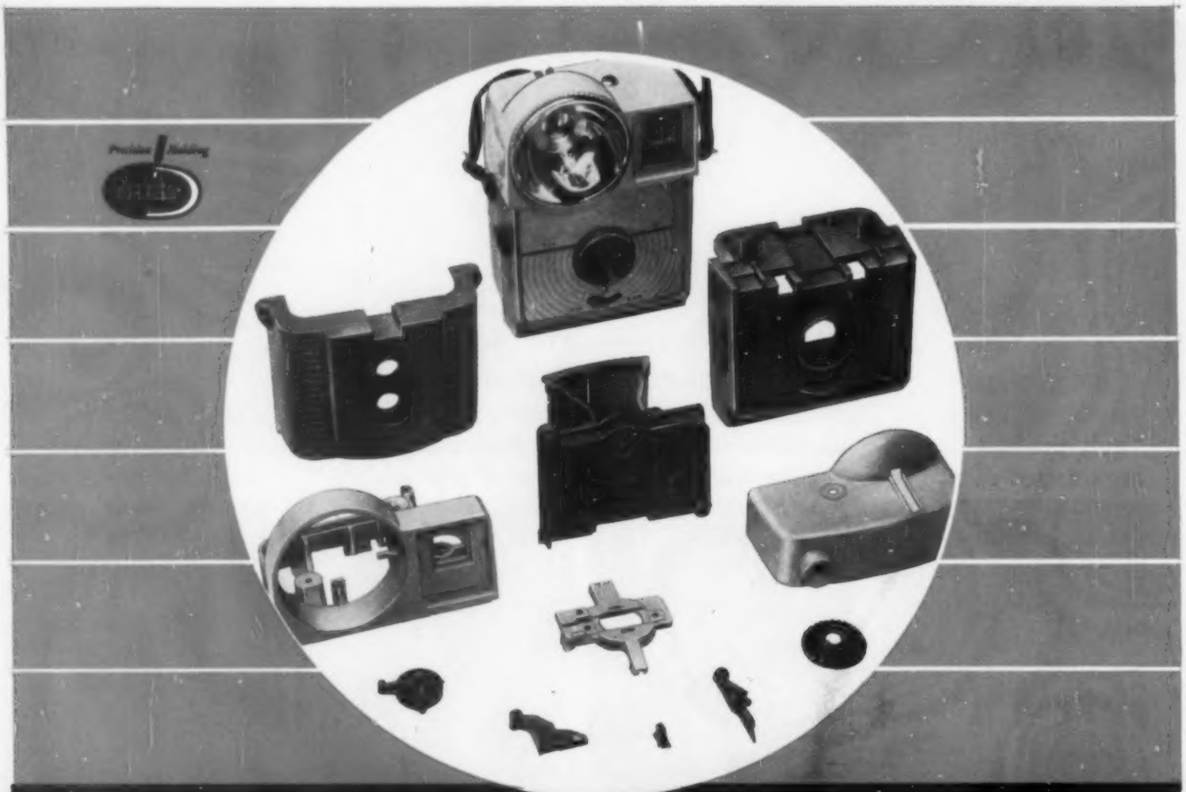
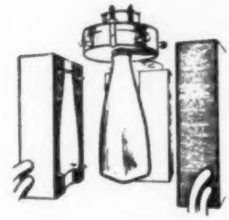
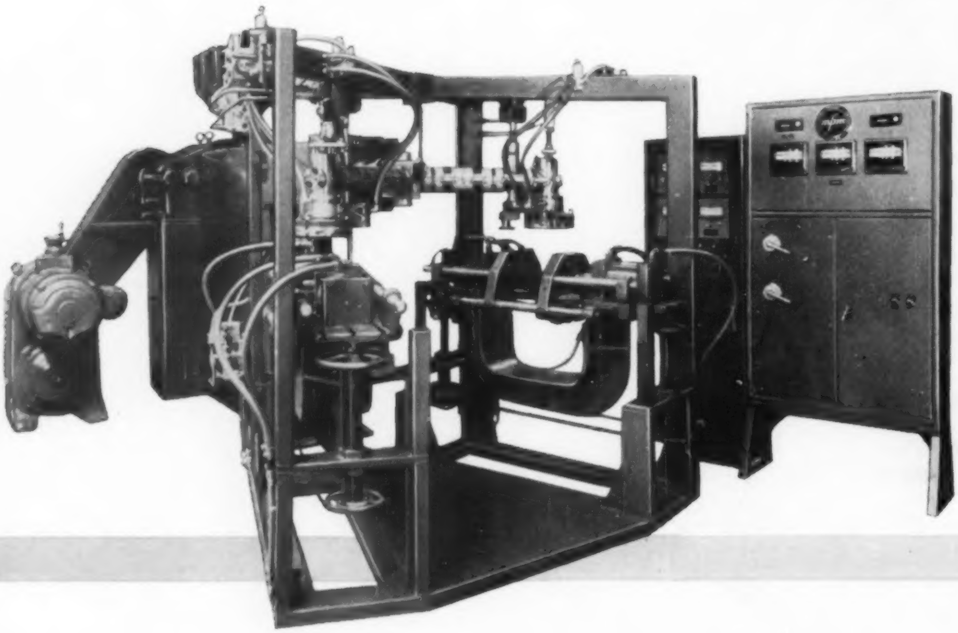
Fred S. Strauss, President of Harte & Company, New York.

accents



Interested in Blow Molding?





MPM's new "Diversamatic" twin-station is the fastest, most versatile unit available.

You owe it to yourself to check the advanced design features of MPM's new "Diversamatic" blow-molding machine.

Unique twin-station design lets you operate two identical or different molds at the same time. Once the machine is set up (easily done with manual controls), you switch over to automatic for high-speed, continuous operation.

You can produce single or vertically strung multiple-cavity work in lengths of up to nearly three feet! Materials blown include low- and high-density polyethylene, polypropylene, high-impact styrene, nylon and other materials.

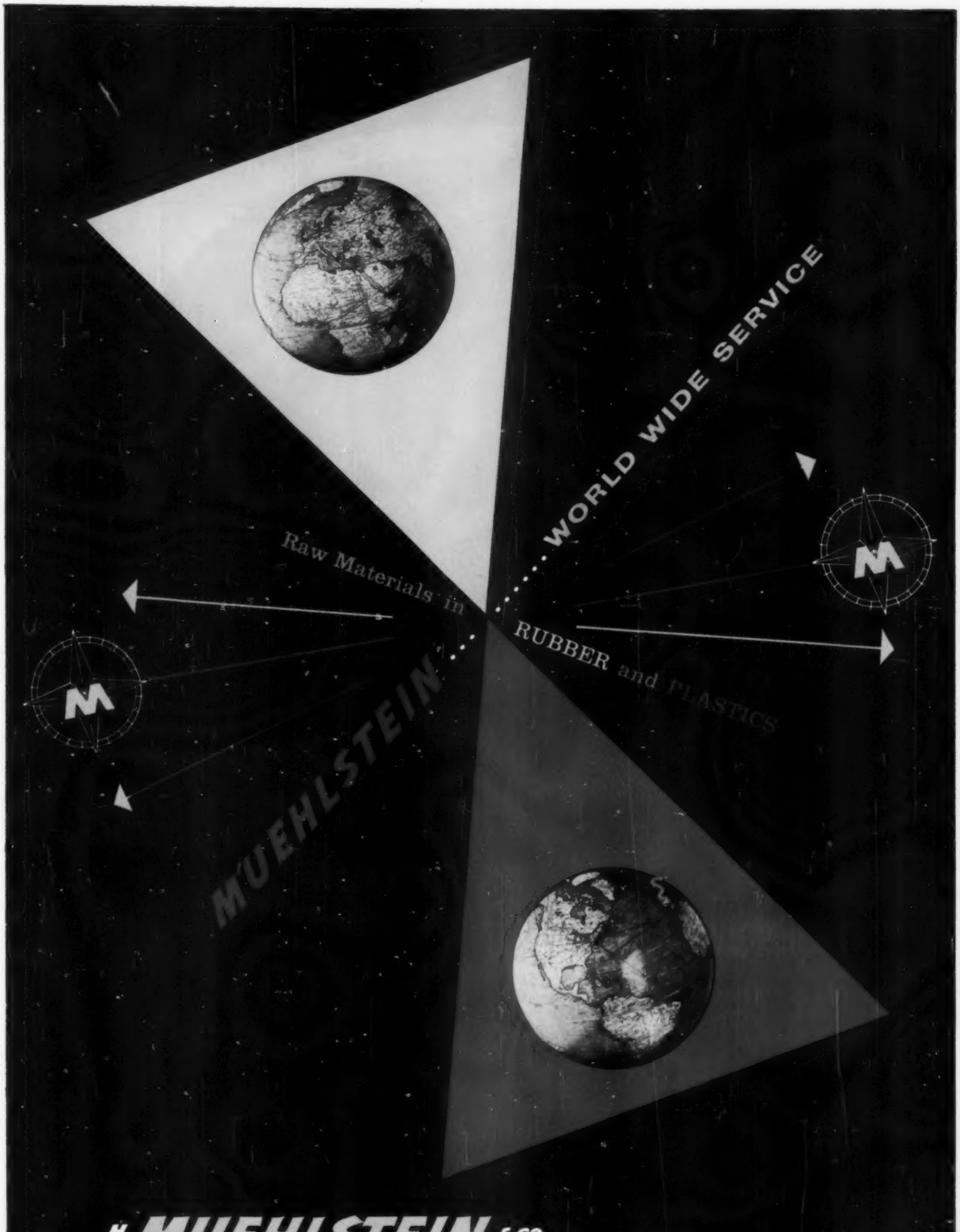
The "Diversamatic" can be used with *any* extruder, domestic or foreign. If you wish, MPM will provide the *complete* unit, including extruder (see photo at right). Moreover, MPM will operate the unit for your inspection *prior* to shipment, then help you put it into operation in your plant.

In addition to the "Diversamatic," MPM manufactures a one-station, two-head machine, two-station machines with either four or eight heads, and a new six-station *rotary* machine. For information on any or all of these, just drop us a note.

MPM COMPLETE PACKAGE UNIT includes an MPM extruder, "Diversamatic" twin-station blow-molding equipment, and the tooling, if desired.

Modern Plastic Machinery Corporation

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.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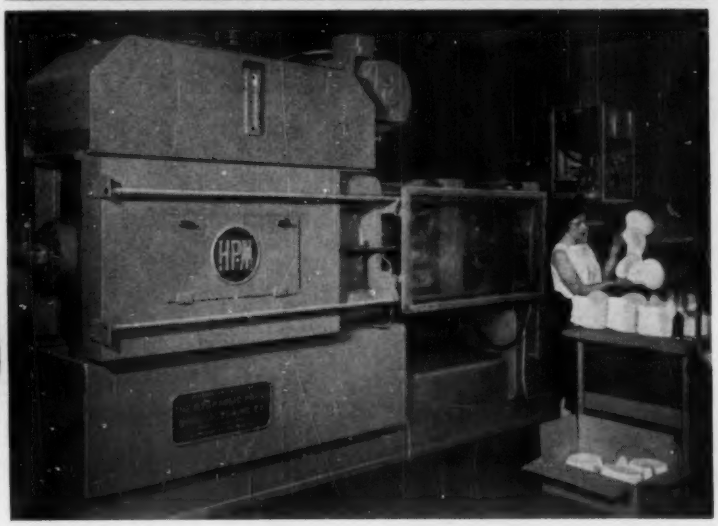
H-P-M Model 200-H-6/8A injection machine running fully automatic, molding flower pots at Earl Fisher Plastics, Inc., Columbus, Ohio. A versatile, high speed producer for a wide range of jobs.

A Pair for Comparison



H-P-M Model 350-HV-12/16 injection machine, molding bicycle seats for The Troxel Mfg. Company of Elyria, Ohio by The General Industries Company, Elyria. This new 12/16" machine is fast, versatile — has all new design for highest production, minimum maintenance.

SPECIFICATIONS	200-H-6/8A	350-HV-12/16
Daylight (in.)	25	34
Daylight with Ejector Box Removed (in.)	29	42
Stroke (in.)	15	22
Clamp Tonnage	200	350
Platen Size (in.)	26x26	34x34
Mold Space (max.)	15x26	20x34
Plasticizing Capacity (lbs/hr.) (general purpose (polystyrene)	90	150
Injection Rate (cu. in. per. min.)	675	1230
Electric Motor (HP)	30	60
Booster Power Units Available To Increase Injection Rate To (cu. in./min.)	1350	2110
Additional HP Required For Booster Power Units	20	30

Here's a pair of money-makers in the wide open 2-oz. to 16 oz. range that will furnish that "one-two punch" for any busy molding plant. These exceptionally fast-cycling H-P-M injection machines have proven themselves in dozens of shops, producing up to 600 shots per hour — consistently. They will handle the big percentage of all molding jobs being run today. They're fast, dependable and easily maintained. Your H-P-M field engineer is looking for an opportunity to prove what these machines will do for you. Write or call today for complete information on H-P-M machines for injection, compression, transfer and reinforced plastics molding.

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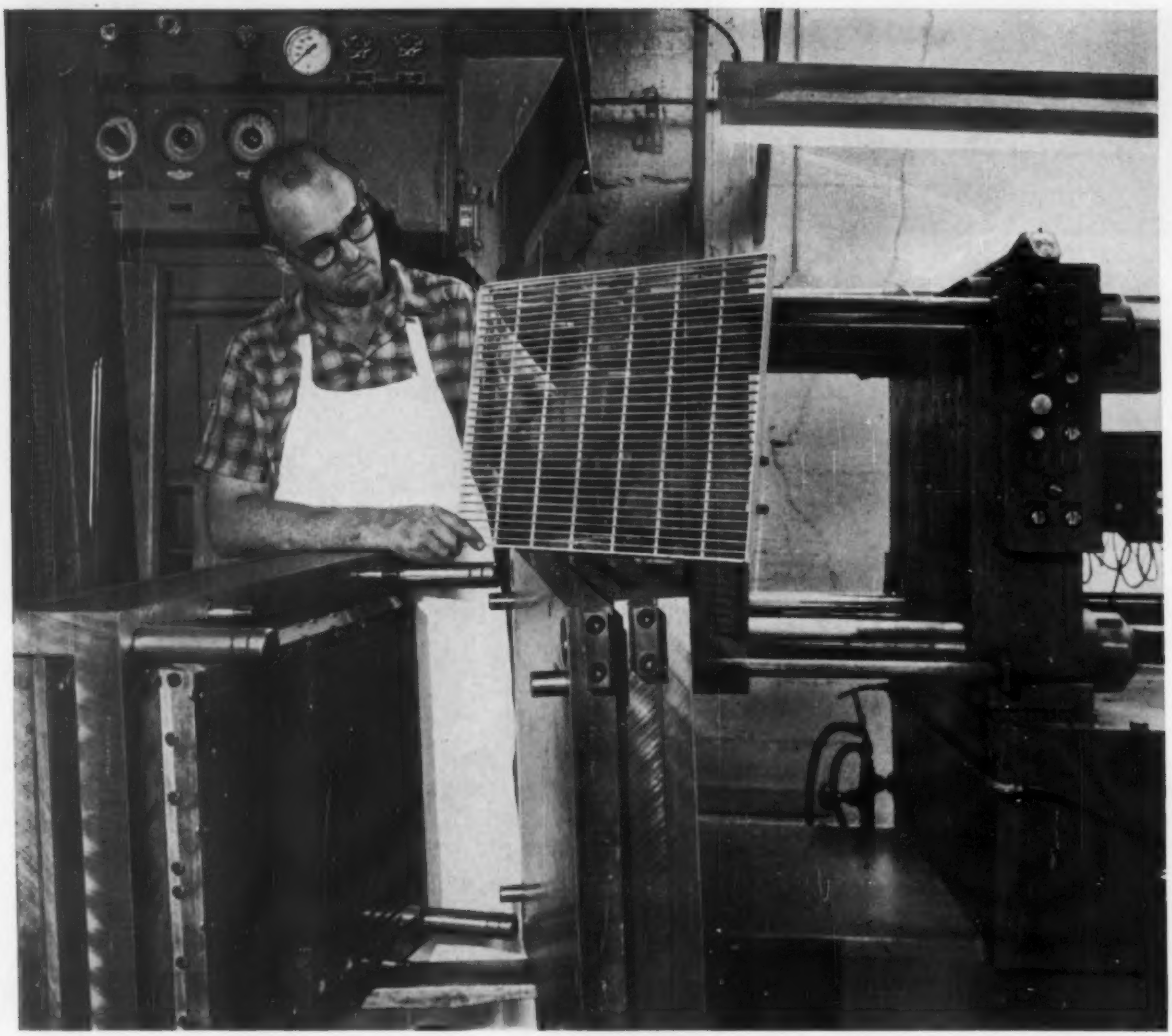

Plastic grille for air conditioner molded in a breeze with **Lustre-Die**

One every minute! That's how rapidly this plastic grille for an air conditioner was molded at Midwest Plastics Corporation, Wichita, Kansas. Using a die made of Bethlehem Lustre-Die tool steel, they produced a perfectly formed grille each time—and with a high sheen. The grille measures 21½ x 15 in., and is ½ in. thick.

Lustre-Die tool steel is ideal for plastic molders because it requires no heat-treatment, and is easy to machine. Lustre-Die polishes beautifully, assuring an eye-appealing gloss on finished plastic parts.

Lustre-Die is made in the electric furnace. Its manufacture at every step is carefully controlled to insure freedom from porosity. It has a well-balanced analysis, and can be polished to a high gloss. Its special alloy fortification increases its depth of hardenability, and enhances its fine mechanical properties. Lustre-Die is oil-quenched and tempered in our mill. When it reaches you it's ready for machining and polishing.

Now is a good time to give Lustre-Die a trial. Your Bethlehem tool steel distributor has Lustre-Die in stock, and can supply you promptly. Call him today.

Steel for Strength . . . Economy . . . Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
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BETHLEHEM STEEL

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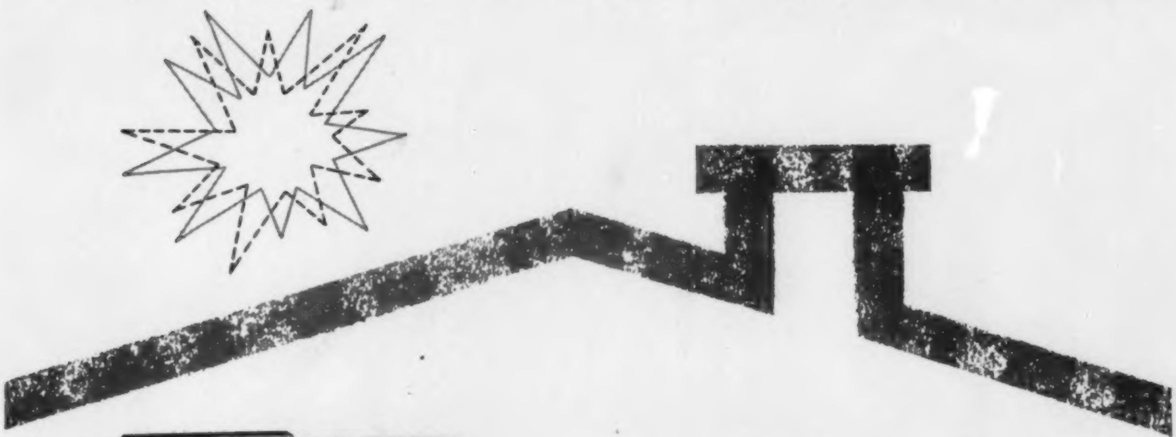
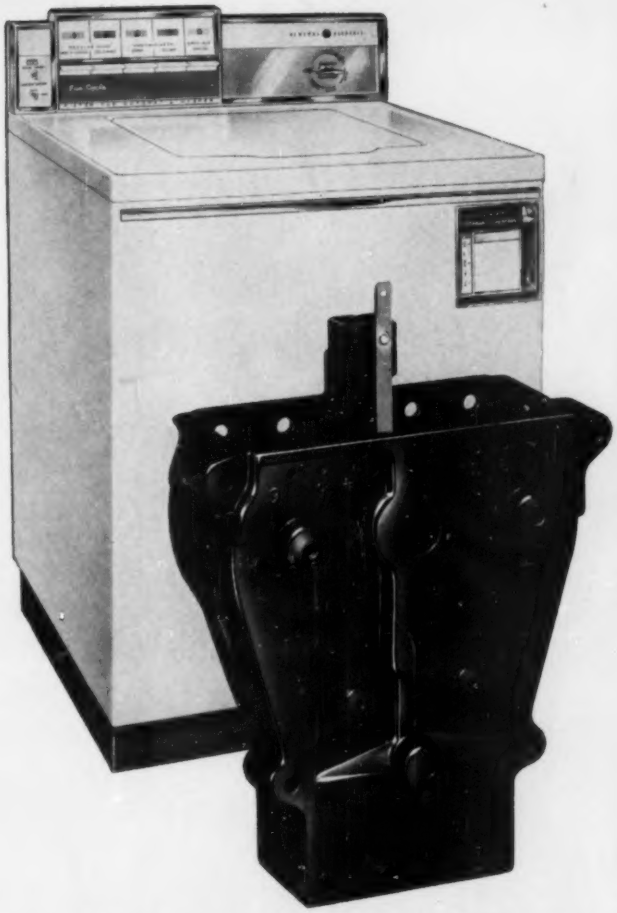
IF PHENOLICS CAN DO IT, **PLENCO** CAN PROVIDE IT . . . AND DOES . . . FOR **GENERAL ELECTRIC**





General Electric solves a housing problem... with the help of PLENCO

PHENOLIC MOLDING COMPOUNDS

Minding the wash from start to finish is the job of the timer. To do a good job of control, it must be well protected—against heat, moisture, vibration, impact.

The right housing is the answer. *And* the right molding material; the General Electric Company, Major Appliance Division, Louisville, Kentucky, found it with Plenco 466 H.R. Black, a special-purpose phenolic compound formulated for excellent resistance to heat and for extra durability.

GE engineers report Plenco 466 the only molding material presently approved for this specific use in General Electric's automatic washer line. It has been used by the Home Laundry Department for over two years.

Basis for approval: This special-purpose phenolic meets General Electric's engineering and test requirements of dimensional stability—insulating properties—heat resistance. During total product tests simulating rugged railroad car vibrations and impact caused by sudden stops and actual drops, this housing came through beautifully. In addition, to assure top performance, this component part withstood 120°F temperatures with a 100% humidity condition.

Weathering the most severe tests of our customers is nothing new to Plenco. We're pleased that Plenco continues to measure up to industry's highest engineering standards. We're confident that Plenco molding compounds, ready-made or custom-formulated, can measure up to yours.

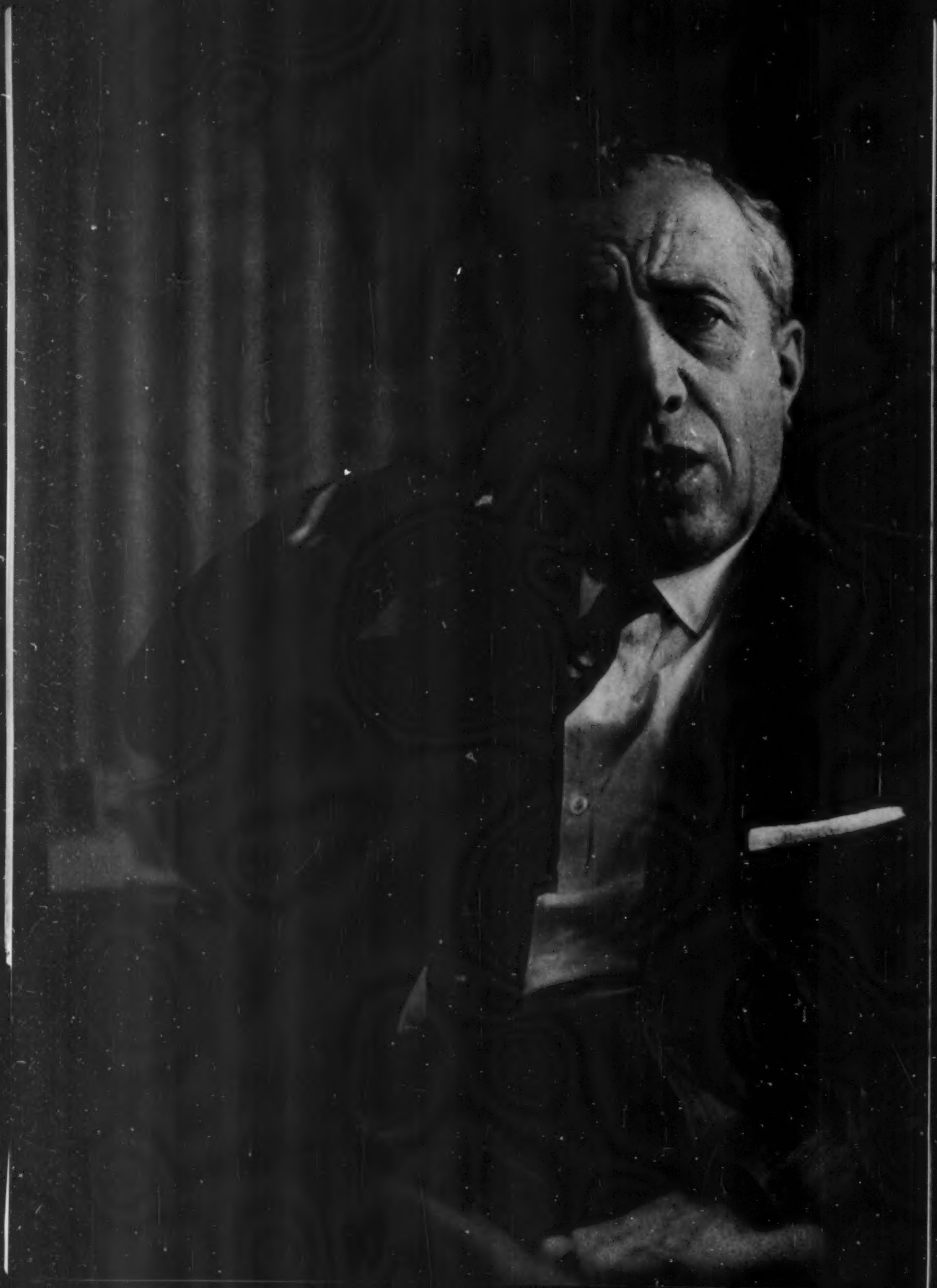
PLASTICS ENGINEERING COMPANY

Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

PLENCO PHENOLICS

FOR BETTER PLASTIC PRODUCTS



End

Problems of Environmental

Stress Crack

in housewares, containers, spouts and closures of molded polyethylene, with new

Spencer "Poly-Eth" 4200 Resins

Will your product fail your customers because environmental stress cracks develop and cut short its useful life? Resins are now available which eliminate or minimize this chronic problem. Why risk it? Read how new Spencer "Poly-Eth" 4200 series resins can greatly increase your product's resistance to this type of cracking:

If you deal in items of molded polyethylene, you are aware of environmental stress cracking. While this problem is not serious in all molded polyethylene products, those that come in contact with certain reagents such as soaps and detergents are subject to this type of cracking.

For instance, when detergents cause a bottle pouring spout or dishpan to crack, environmental stress cracking may be the problem. Now, at no extra expense, you can overcome this major cause of cracking!

Upgrade your polyethylene product by molding it of new Spencer "Poly-Eth" 4200 resin—the advanced new polyethylene molding resins that laugh off environmental stress cracking. It costs no more to put this important extra durability into your molded product. Just specify a new Spencer "Poly-Eth" 4200 series resin!

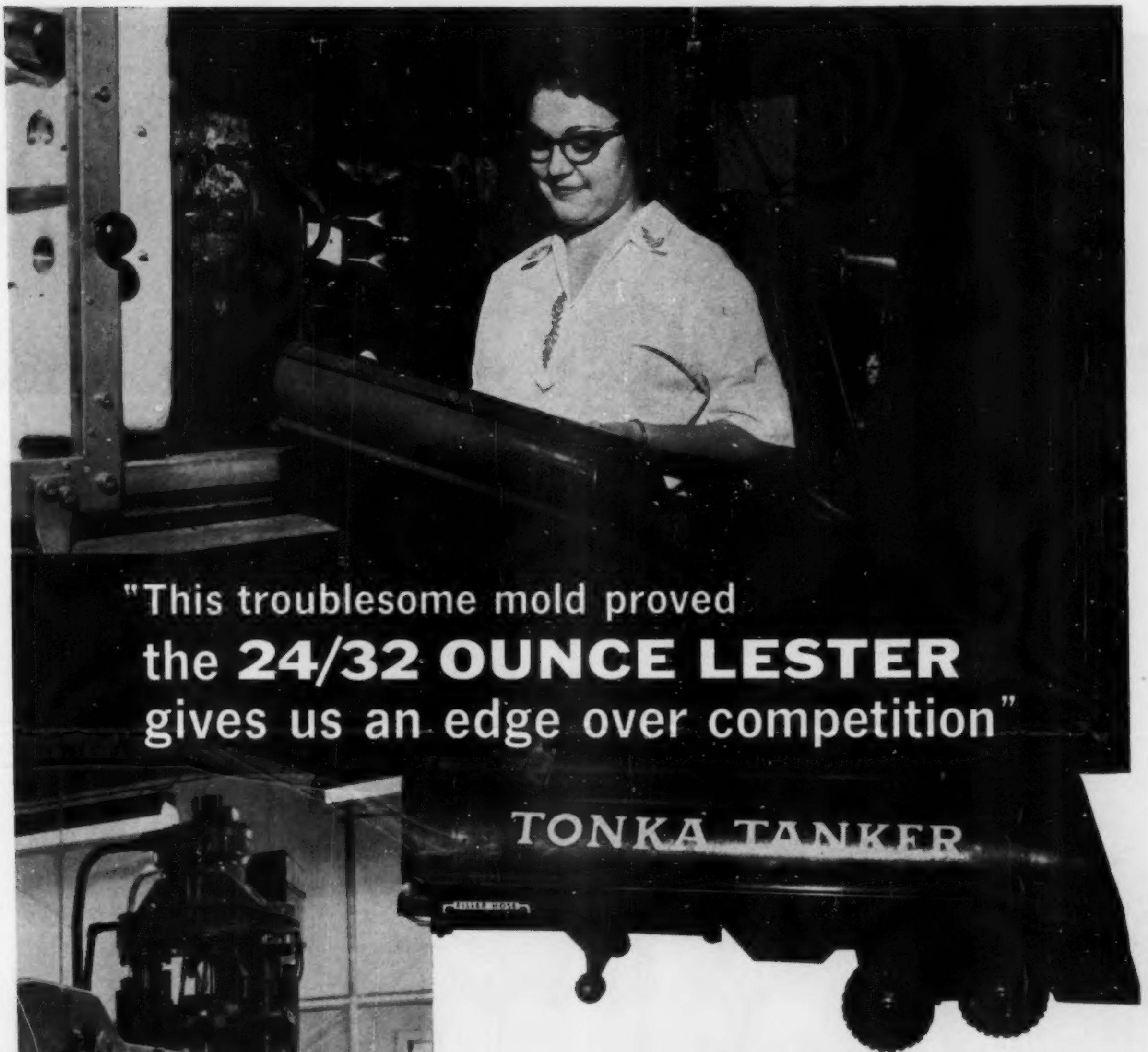
Free technical assistance is available to help you discover how these amazing new Spencer "Poly-Eth" 4200 resins can improve your molded product. Without obligation, our technical representative will be happy to work with polyethylene molders. Write now at the address below for further information.

Test results demonstrate the high environmental stress crack resistance of new Spencer "Poly-Eth" 4200 resins. Comparison was made under *standard ASTM test conditions* using specimens made of competitive polyethylene resins. The vast superiority of Spencer "Poly-Eth" 4204 amazed even us!

SPENCER Poly-Eth Polyethylene

SPENCER is also a prime supplier of POLY-PRO POLYPROPYLENE SPENCER NYLON

SPENCER CHEMICAL COMPANY, DWIGHT BUILDING, KANSAS CITY 5, MISSOURI



"This troublesome mold proved
the 24/32 OUNCE LESTER
gives us an edge over competition"

"This Tonka Tanker was being tested in other shops on 30 to 40 ounce equipment. The only way it could be run was on a prohibitively long cycle. Anything less, resulted in short shots, weld and sink marks and other finish problems. The job was so tough to run that the mold was suspected of being poorly engineered," says Bruce Schroeder of Empire Plastics, Inc., in Loretto, Minn.

"We put the mold on the L-500-24/32 ounce machine in our all-Lester shop and it took off at 60 shots per hour, running 21 ounces of Implex, a hard-flow, viscous, modified acrylic. The finish was perfect and we got a full shot every time."

The 24/32 ounce Long Stroke Lester with 500 tons of Certified Clamp and adjustable mold stroke of 8" to 30" is daily meeting the demands of capacity, clamp and stroke for big, tough jobs up to 40 ounces. Detailed specifications are available on request.

L LESTER ENGINEERING CO. CLEVELAND, OHIO 25th ANNIVERSARY

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Grote Manufacturing uses the Natco 300 for Acrylic Reflex Reflector Lenses and Other Precision Lenses.

"Pioneers in Automatic Molding Machines Now Use Natcos"

Says Mr. E. Q. B. Henriques, Company Director

Mr. Henriques of Grote Manufacturing Company, Madison, Indiana indicated they were one of the first builders of Automatic Molding Machines back some twenty years ago.

Further comments were: "Natco machines are more versatile and everything is completely accessible. They are faster acting and have ample injection capacity. The results are better parts . . . and fewer rejects. And we find it has the fastest cycle time of any machine its size."

If molders such as Grote rely on Natco, there has to be a reason . . . and that reason is productivity.

For more information on the Natco 12 to 80 oz. capacity Injection Molders write for Bulletin 2001.

Molding 23 oz. Home Laundry Machine Panels on the Natco 400X at Kusan.

"We Like the Speed of Our Natco 400X"

Says Earl C. Horton, KUSAN's Executive Vice President.

"Natco's fast clamping action and high speed injection help trim seconds off our molding cycles. The large platen area, together with big shot capacity and fast filling speed, enables us to run large molds profitably."

Mr. Horton of Kusan, Inc., Nashville, Tennessee further commented, "Natco's accessible cycle controls are appreciated when setting-up molds. All of these features help us produce profits on many difficult jobs."

Investigate what Natco Injection Molding Machines can do for you. Available in stock sizes from 12 to 140 oz. Write for Catalog #2001.

Aladdin Molds Picnic Snack Box and Cover on the Natco 200

"We Like the Versatility of Natco's Hydraulic Mold Clamp"

. . . . . Says Charles Allen, Molding Foreman at Aladdin Industries

"As manufacturers of vacuum bottle and snack box accessories, our molds require unusual clamping cycles. We find that Natco's straight hydraulic clamp gives us precise control of mold position and mold opening and closing speeds. Interrupted or delayed action of the clamp presents no problem with our Natcos."

Mr. Allen, Foreman at Aladdin Industries, Inc., Nashville, Tennessee, says, "Having the controls for hydraulic, temperature and time within easy reach of the operator is a real convenience. Our operators like to run the Natcos because of these features."

For complete information on Natco 12 to 140 oz. Injection Molding Machines write for Catalog 2001.

Demaree Molds a 12½ oz. Styrene Urn Planter on their Natco 300.

"Our Natco Increased Production 25 to 50%!"

Says Mr. D. E. Demaree Sr., President of Demaree Molded Plastics

"And in addition to the production increase we have found the Natco much quieter with no vibration, cleaner with no messy oil leaks and more machine than others for its size."

Mr. Demaree, President of Demaree Molded Plastics, Inc., Kokomo, Indiana is very happy with their Natco 300. He further commented, "that Natco seems to have concentrated on a lot of little details which mean so much to an injection molder."

These little details can mean just as much to your molders too. Write for Bulletin 2001 for complete information on the Natco 12 to 80 ounce Injection Molding Machines.

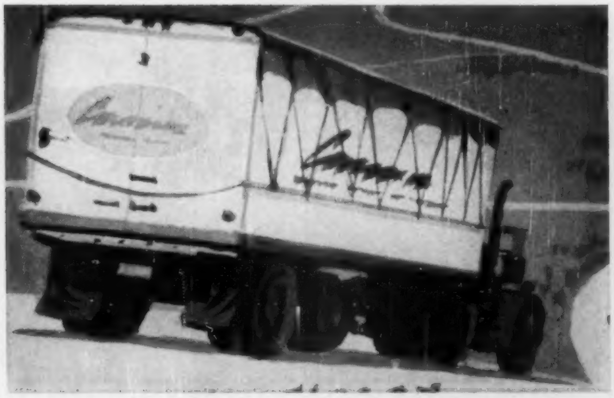
NATCO

THE MOLDER'S MOLDING MACHINE

NATIONAL AUTOMATIC TOOL COMPANY, INC.

PLASTICS MACHINERY DIVISION

RICHMOND, INDIANA, U. S. A.



on land Truck tarps of coated nylon combine lightness, durability and watertightness. "Welkote" nylon base fabric by Wellington Sears.

at sea Hatch loading tents of coated nylon admit light as they protect workmen and cargo from weather. Base fabric by Wellington Sears.

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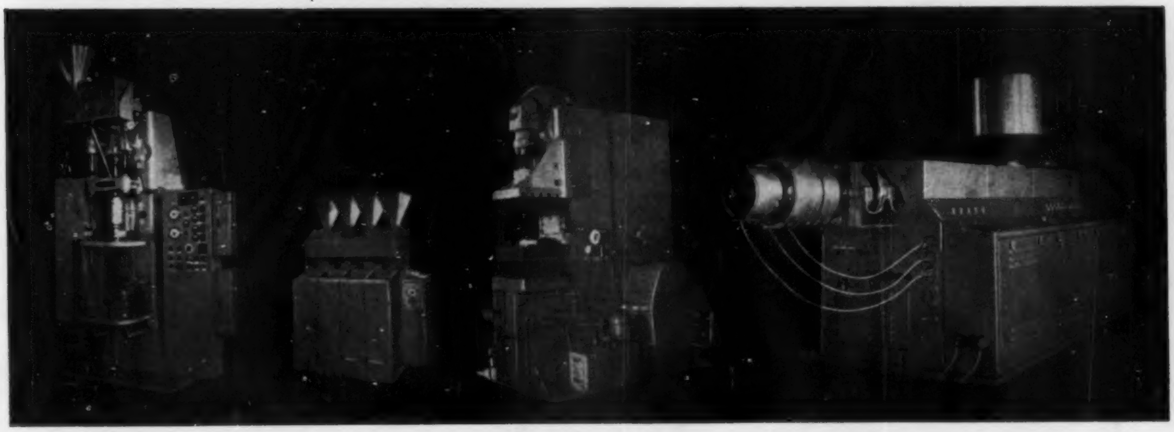

Blow Molding Machines with piston and screw feed up to 215 pts

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Compression and Transfer Molding Machines up to 300 tons capacity

Extruders and complete Automatic Plants (with screw diameters 1¼" 1¾" 2½" 3½" and 6" approx)

INJECTION MOLDING MACHINES

from 1/10 oz. upwards

with
SCREW PLASTICIZING
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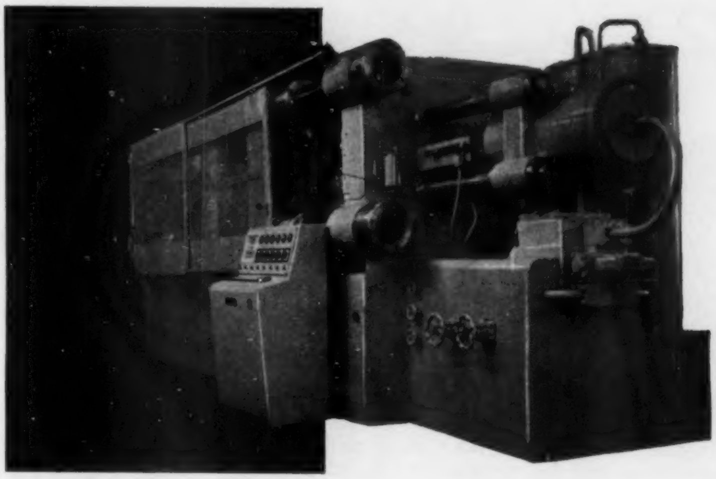
from 1 — 350 OZS



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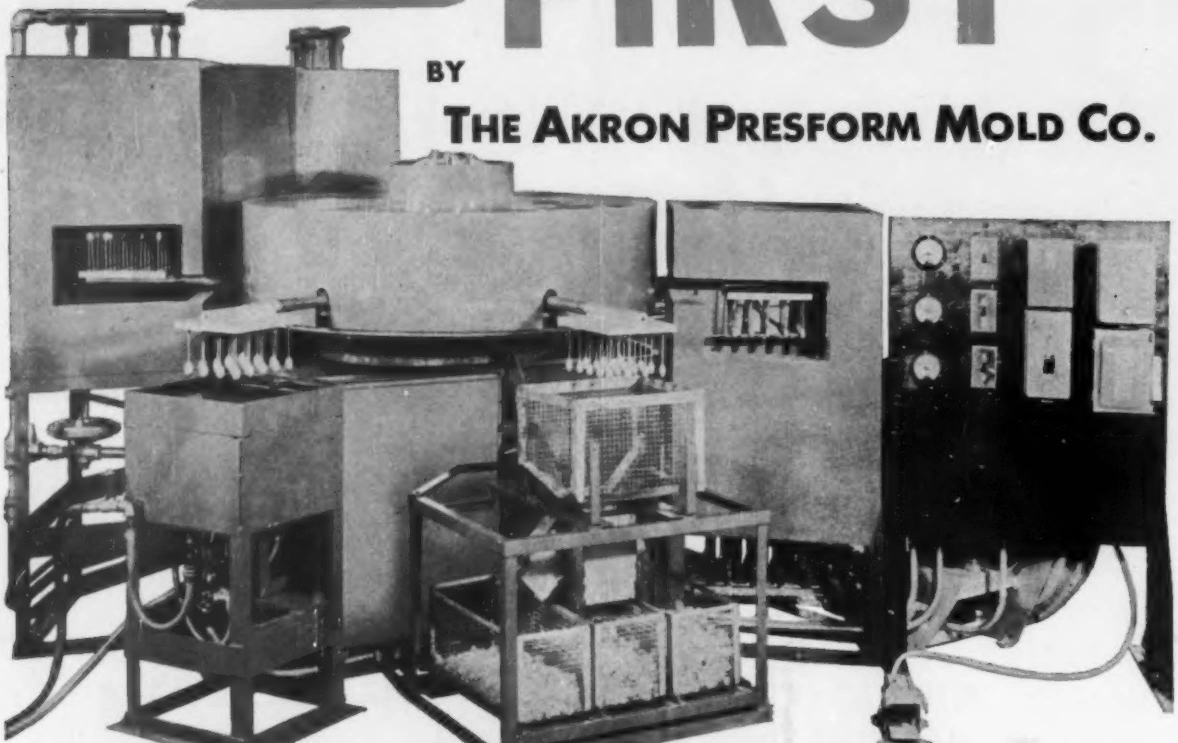
BY

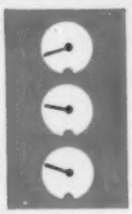
THE AKRON PRESFORM MOLD CO.



NEW

AUTOMATIC DIPPING & COATING MACHINE
MAKES 12,000 ITEMS PER HOUR!

Fully automatic, this vinyl plastisol dipping machine will produce dipped goods at rates up to 12,000 items/hr. This six-station machine preheats forms, dips, thermosets film, cools, strips and sorts, completing the cycle in as little as 36 seconds! Cycle regulating gauges are calibrated in seconds so the time cycle and temperatures can be set exactly. Up to 20 forms may be mounted on each form-carrying plate, and three different items can be made simultaneously and automatically sorted. Only 8 x 10 ft. of floor space is required, and the machine is 5 ft. high.



Regulates in SECONDS not minutes!

- NON-TECHNICAL OPERATOR
- LOW-COST FORMS OR TOOLING
- ONLY 80 SQ. FT. FLOOR SPACE
- EASILY INSTALLED IN YOUR PLANT UNDER OUR SUPERVISION
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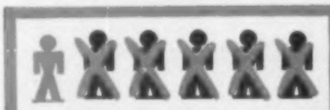

ONE OPERATOR FOR SIX STATIONS

The operator need not be a technician. His duties are merely to supply the material tank and remove tote boxes of finished, sorted products!

To see this amazing profit-maker in operation or on film, call or write:

THE AKRON PRESFORM MOLD COMPANY

Where "KNOW-HOW" is the most important product!

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FORMS	MOLDS	DIES	MACHINERY
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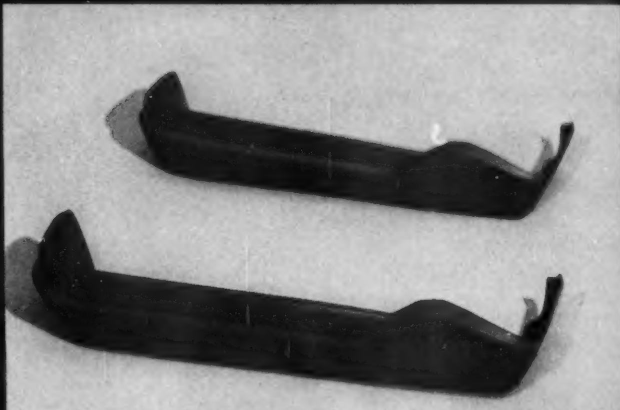
Spring Silencers and Heater Duct—MARLEX silencers are durable, self-lubricating, and less costly. Duct is flexible, rot-proof, withstands tears and punctures.



Seat Side Shields—Cost less than painted steel . . . dent and scuff resistant, lighter, easily cleaned, and with "molded in" texture and color.

Windshield Washer Jar—MARLEX container and lid won't shatter or burst . . . are unaffected by freezing or under-the-hood temperatures.

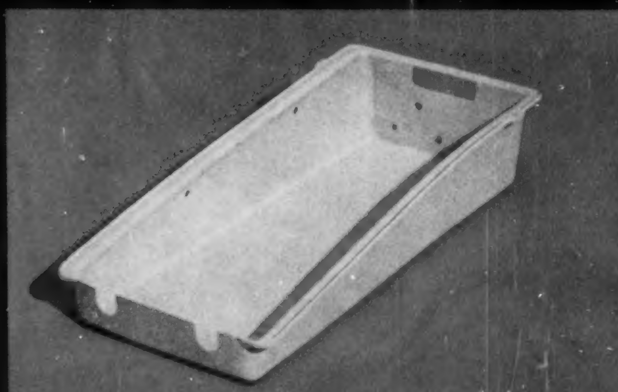
The MARLEX* look on 1961 cars

Shown here is a selection of current applications for MARLEX variously used by American Motors, Chrysler Corp., Ford, and GM. They offer new proof of the improved performance (at comparable or lower costs) provided by this versatile, high density plastic.

MARLEX items (like the original equipment applications shown here) are unaffected by extremes of temperature (—180°F to 250°F) and resistant to acids, alkalies, oil and grease. They are lightweight, tough, durable, non-allergenic, corrosion- and rot-proof . . . can be machined, welded, bolted, and printed upon. There are production advantages, too. Superior finished items can be quickly and economically produced from MARLEX high density resins by injection molding, extrusion, blow molding or thermoforming.

Technical and design data on MARLEX high density polyethylenes and ethylene copolymers, and their many uses, is available to you.

Side Cowl Panels—Colorful and textured MARLEX panels improve styling . . . will not scuff, dent, or tear . . . are color fast and easily cleaned.



Glove Compartment—Economical "quality upgrading" with MARLEX . . . new box is rugged, functional, and longer lasting.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma, a subsidiary of Phillips Petroleum Company

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PHILLIPS 66 MARLEX

THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

Section 1

March 1961

When "big" fellows get together

The most startling surprise in plastics materials happenings since Tenn.-Eastman's announcement in 1953 that it would follow Du Pont and Union Carbide into polyethylene production was the joint move by Union Carbide and Shell Chemical to start making polypropylene and high-pressure polyethylene for each other. Even many high officials in both companies were startled by the news.

There have been somewhat similar moves in the industry in the recent past. Examples are the National Distillers-Phillips arrangement and other various exchanges of linear for conventional polyethylene by nearly every producer who doesn't make both. But there has been nothing on the scale of the Union Carbide-Shell combination. Obviously, both companies are interested in saving the capital investment required to build facilities and develop markets for resins in which tremendous over-capacity is foreseen within the next two years.

Shell's new 80-million-lb.-capacity polypropylene plant in Woodbury, N. J. is expected to come into production in mid-1962. The decision to enter the polypropylene field was a comparatively fast move for Shell, which was one of the first big petroleum companies to show determined interest in the petrochemicals and plastics industry. Way back in the late 1940's Shell carefully investigated the vinyl chloride, polyethylene, and benzene markets—indeed the company even operated a PVC plant in Europe. But for one reason or another, plans to build in the U. S. were continuously postponed until the vinyl and polyethylene fields were overcrowded. Even its polystyrene operation was a long time getting under way after purchase of a monomer plant. Apparently there was no such hesitation with polypropylene, and the acquisition of an immediate supply of high-pressure (conventional) polyethylene without building a plant makes their previous hesitation appear as a right smart maneuver.

Incidentally, it seems that neither company is concerned about composition of matter patents.

Shell's position in plastics

Shell Chemical is now in position to become a highly potent factor in plastics materials within a short time. The company was a pioneer in and is now the largest producer of epoxy resins. It started selling styrene type resins about two years ago. Polyethylene will be available from Union Carbide just as soon as Shell can complete marketing plans. There should be no shortage, since Carbide will soon have a capacity of between 600 and 700 million pounds. When its polypropylene is ready, Shell will have as diverse a line as almost any raw materials company in the business.

Shell is also involved in plastics production in Europe. In England, it makes linear polyethylene and/or polypropylene under license from Ziegler, makes polystyrene, is building a high-pressure PE plant, and operates with Kordite a polyolefins film plant. In Holland, Shell makes PVC and is building a polypropylene plant with Montecatini. In Germany, Shell operates a plant with Badische to produce high- and low-pressure PE. **(More on page 41)**

*Reg. U.S. Pat. Off.

Escon®

POLYPROPYLENE

GIVES YOU A BALANCED COMBINATION OF PROPERTIES...

When you take *all* the facts into consideration, you'll discover that Escon polypropylene gives you unusually high performance at low cost.

And, Enjay has complete commercial fabrication equipment to help solve your processing problems.

For technical assistance, write to Enjay at 15 W. 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

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PLASTICS

THE PLASTISCOPE

National Distillers adds to linear PE capacity

A new 60-million-lb./year, low-pressure process polyethylene plant will soon be under construction for National Distillers (U.S.I.) at Houston, Texas. It should be completed late in 1962. The resin will be made under license from Phillips.

National Distillers now has facilities for producing 300 million lb. annually of conventional polyethylene. It can supply linear material from a pilot plant and has a resale arrangement with another linear PE producer. The company also supplies conventional PE to Phillips, so that the latter company may also offer a complete range of densities.

Dr. Robert E. Hulse, National's vice-president and general manager, indicated that he had no fear of running into an over-capacity situation for linear PE, since he thought it would be in short supply by early 1963.

Present indications are that 400 or 500 million lb. of capacity for linear polyethylene will be available in the United States in 1963. For 1960, consumption was estimated at 170 million and capacity at about 300 million pounds. Prognostications in this area are fantastic—one producer says that 600 million lb. will be sold in 1965, with consumption for blow molding alone rising to 300 or 400 million pounds.

This may be like betting that Wilma Rudolph will break the men's record and run 100 yd. in 9 sec. flat; but there are a lot of congenital optimists and companies with money to spend in the industry who will bet on it. If price of linear PE ever gets to the same level as conventional PE, there is no telling what could happen to poundage volume, except that the eyes of company directors and stockholders will be brimful of tears. A visit with any polystyrene or vinyl chloride producer today will confirm the low-price-no-profit situation that confronts an over-expanded industry where capacity grows so much faster than demand.

Higher-molecular-weight linear polyethylene

Celanese Polymer Co. got the jump on producers of Phillips-type linear polyethylene when it announced development of a new line of high-density resins with longer molecular chains or higher molecular weight. Since Phillips itself and its licensees—W. R. Grace, Celanese, and National Distillers—work interchangeably on all new developments, it is assumed that all producers of Phillips-type resin have the same formulation.

The big advantage of the material is that it is supposed to be as easy to process as standard high-density polyethylenes, in contrast to other higher-molecular-weight linear PE's, which are said to be more difficult to handle. Hercules, which has developed a high-molecular weight Ziegler-type linear resin especially for bottles, wire coating, and pipe may well dispute this claim; and Allied Chemical, too: the company has its own molecular weight resin especially for pipe, although critics have said it requires special handling to force it through an extruder.

According to Celanese, the new formulation, called Fortiflex R, not only processes at a faster rate but also imparts better properties. Among advantages claimed are greater resistance to high pressures and temperatures, better impact, more uniform wall thickness, more attractive appearance for such applications as pipe, auto and appliance parts, containers, wire coverings, paper coatings, and large molded housewares. Celanese also states it will be better for detergent bottles, but other linear producers imply that their present bottle-blowing resins are completely adequate for the job. **(More on page 43)**

CAMPCO

Plastic Sheet and Film

some practical IDEAS for its use

Campco Styrene helps make Jr. Juke kid-proof

This Jr. Juke is a hit with kids and parents alike. That's because the base is formed with Campco S-540 Styrene, an extra high impact strength material, attractive yet durable and tough enough to resist children's rough treatment.

Economical In addition to strength and durability, Campco S-540 has excellent formability characteristics. This proved to be especially important in the deep drawing process used in forming the base. With S-540, complicated curved surfaces and debossed areas can be formed quickly and accurately. Higher production rates and greater economies result.

Special Finish Chanal Plastics Corporation of Rego Park, New York, who vacuum forms the Jr. Juke housing for Shell Electronics of Long Island, specified Campco's "GM" finish. This high-gloss surface, developed and pioneered by Campco, is achieved with a thin coating of compatible glossy material—applied in a manner that it becomes an integral part of the sheet itself. Even in extremely thin forming operations, the brilliant gloss remains unimpaired.

Other Finishes Campco S-540 rubber modified styrene sheet can also be supplied with a mat finish on both sides (MM) and a polished-smooth surface on one side and a mat finish on the other (PM). Available in a full range of colors.

Campco Styrene lightens load in mobile homes

Du Call Miller Plastics Co., of Cicero, Illinois, uses Campco S-540 rubber modified styrene sheet to vacuum form this mobile home sink for C. M. Hoof Co., Evanston, Illinois. Campco's GM high-gloss finish gives the sink a sparkling, china-like appearance, and its nonporous surface assures easy cleaning.

Strong, Light in Weight S-540's high impact strength properties make it possible to achieve dramatic weight reductions in many applications. The sink illustrated, for example, weighs less than one pound, a weight savings of at least 10 lbs. over comparable vitreous types. These high strength and light weight characteristics make Campco S-540 ideal for a wide variety of uses in appliances, toys, and housewares.

Planters formed from Campco Styrene

The Plastics Division of Kusan Incorporated, Nashville, Tennessee, selected Campco extra high impact styrene to form this handsome planter and matching tray, marketed nationally by Ferry Morse Seed Company of Fulton, Ky.

Low Moisture Absorption An important requirement for this application was a material with low moisture absorption properties. Campco Styrene easily met this requirement and offered, in addition, excellent formability and the ability to withstand wear. This same combination of properties has helped make Campco Styrene a popular choice in a wide variety of applications.

Received Your Campco Personal File? This data-packed reference file on thermo-plastic sheet and film is yours on request—just send name and address on your company letterhead to Campco, 2717-H Normandy Avenue, Chicago 35, Illinois.

CAMPCO Sheet and Film, **a Division of Chicago Molded Products Corp.**

THE PLASTISCOPE

New polypropylene plant on stream

Texas-Eastman's 20-million-lb. polypropylene plant at Longview, Texas is now on stream. The resins produced there have been market-tested for over a year. Flow rates extend from a melt index of 4½ to 18, the latter of which is claimed to be highest on the market. The material is also said to have a low ash content. This property is claimed to improve the resin's resistance to thermal breakdown and to result in improved quality and stability of color. Company spokesmen say that 460 million lb. of polypropylene will be total capacity in this country in 1962. Current foreign production is estimated at 118 million lb. at present—may be over 400 million lb. in 1963.

Estimates for polypropylene sales in 1965 go as high as 450 million pounds. Eastman's breakdown of this consumption is as follows: injection molding, 115 million; film, 200 million; monofilament, 35 million; other extrusions, 75 million; textile fibers, 25 million.

Texas-Eastman has been a producer of high-purity propylene since 1951. A process developed by company research for manufacture of polypropylene is said to be free and clear of existing patents; in fact, the company has two processes. Advantages claimed over other polypropylenes are a wider range of flow rates, a wide variety of impact-resistant formulas, and accurate color matching. Eastman also claims its material is particularly resistant to oxidation and light degradation because of the company's long experience in production of antioxidants and ultra-violet inhibitors.

Enjay broadens its range

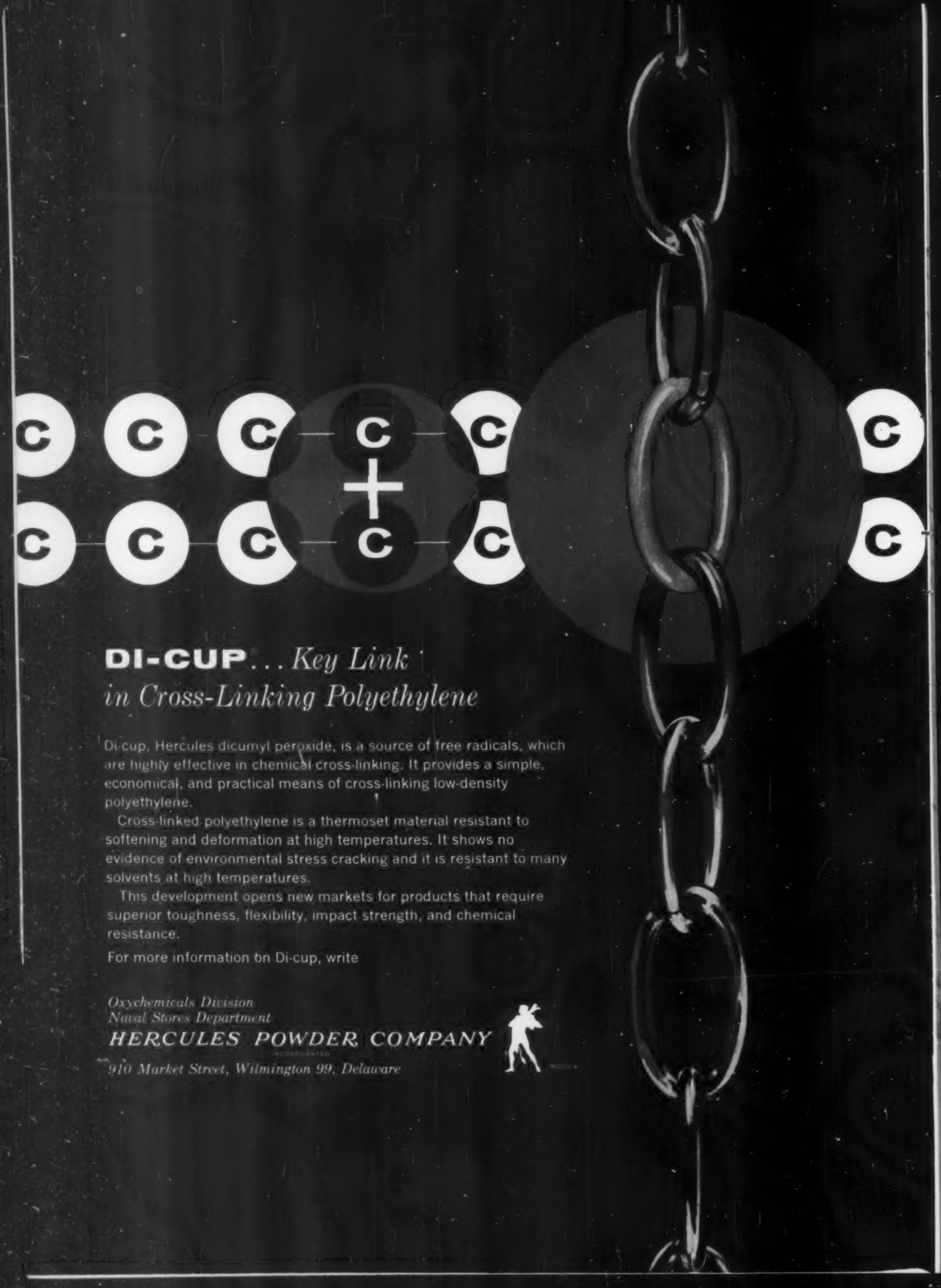
A long-term-heat-aging molding grade polypropylene, with a melt index of 5½, is a new formulation by Enjay. A special stabilizer developed within the company is the secret. Data reported by the company indicate that the new Escon 125 will withstand 80 days' exposure at 300° F., compared with 52 days for the older Escon 105. The company also has three other grades, two of which are comparatively long-term-aging materials. One will go 53 days and the other 40 days. Some of the specimens showed no failure after 6 months at 250° F. General purpose resins withstood only 8 days by the same tests. By this time nearly everyone must know that proper stabilization is the key to polypropylene usefulness, and Enjay is proud of its accomplishment.

All these long-term-heat-aging formulations sell at a premium price of 46 cents. They are suggested for applications in automotive heater ducts, cable connectors, clips for holding cable, television backs, and radio cabinets.

The company also now has a variety of melt index materials (with the lowest, of course, showing the slowest flow). The various melt index rates for Escon are 1½, 3½, 5½, and a 12 which is comparatively new.

Delrin price drops again

The most important property in plastics is P-R-I-C-E. This is the reason why this observer was enthusiastic over Du Pont's Delrin when it was announced several years ago. Of course, its new price of 65¢/lb. is not low compared with other thermoplastics. But it's a substantial reduction from the introductory price of 95¢; and Du Pont officials have never hesitated to state that it will continue to decline in price for some time to come. Delrin is based on formaldehyde, which


DI-CUP... Key Link
in Cross-Linking Polyethylene
Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.
Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.
This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.
For more information on Di-cup, write
Oxychemicals Division
Naval Stores Department
HERCULES POWDER COMPANY
910 Market Street, Wilmington 99, Delaware

is 4¢/lb., but it had taken many years to find a way to purify the material sufficiently for polymerization until Du Pont accomplished the trick some years ago, and the cost of purification is not low. Still, the 65¢ price will certainly go lower, and a comparatively low price for a plastic with metal-like properties is indeed something to brag about.

Another highly important angle in the Delrin story is that it will find many markets in areas where plastics have never competed. It is now less costly than brass or zinc per cu. in. and is particularly adaptable as a replacement for die-cast items.

Delrin is already used in more than 500 applications in the U. S., and other countries have picked it up quickly to produce more than 200 different products. Ladies shoe heels, ball-point pen mechanisms, binocular casings, toothbrush handles, and lawnmower wheels are some of the foreign uses.

Celanese too has just announced development of a resin developed from formaldehyde but has stated that it would be a copolymer. Trademarked Celcon, it will be produced in a new plant at Bishop, Texas, scheduled to begin production in early 1962. Full details will appear here next month. Other major formaldehyde producers are expected to enter the same field in the near future.

Hi-temp Geon in commercial production

In what president Harry B. Warner of B. F. Goodrich Chemical says is the "first significant breakthrough in vinyl since development of the first rigid 13 years ago," his company has announced that commercial production of its new hi-temp Geon will begin about May 1.

The new material withstands boiling water, so that it can be made into household plumbing and industrial piping for hot acids. Such piping is one-sixth the weight of copper and thus offers weight-saving advantages in pre-installation of plumbing in prefabricated walls. It will withstand 50 or 60° F. more heat than previous unplasticized vinyl formulations, or up to 210° F. in continuous service compared with previous vinyl limits of 140° F.

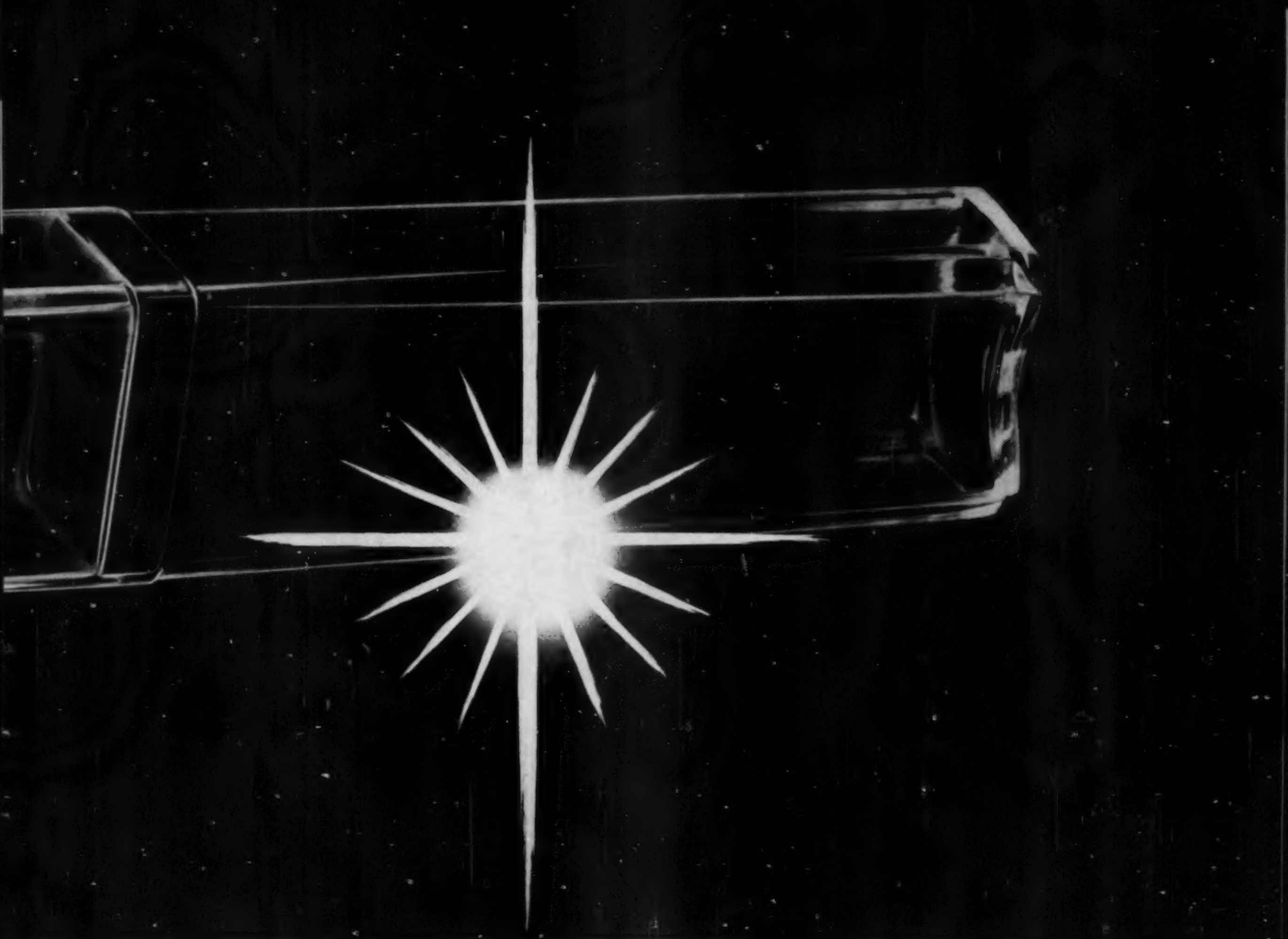
Embedded heater elements

Development of a technique for embedding heater elements in reinforced plastics to satisfy the need for elevated temperature control in enclosed apparatus has been announced by Scheidl Mfg. Co., 1985 Great Neck Road, Copiague, N. Y. The elements are embedded in molded parts so that the advantages of reinforced plastics housings can be combined with space- and weight-saving heater systems.

A metallic film can also be embedded to act as a heat reflector, thereby increasing efficiency. The significant angle here is applying a metallic coating to a thermoset and making it stick. Test units have operated for over 3000 hr. without breakdown. Bendix is using them with the inertial guidance system for an army ballistic missile.

Granted that this development seems destined primarily for defense purposes; but after all that's a $40 billion business. However, the principle is so new and different that the developers are anxious to hear from prospective users in any industry who think they could apply it.

For additional and more detailed news see Section 2, starting on p. 212



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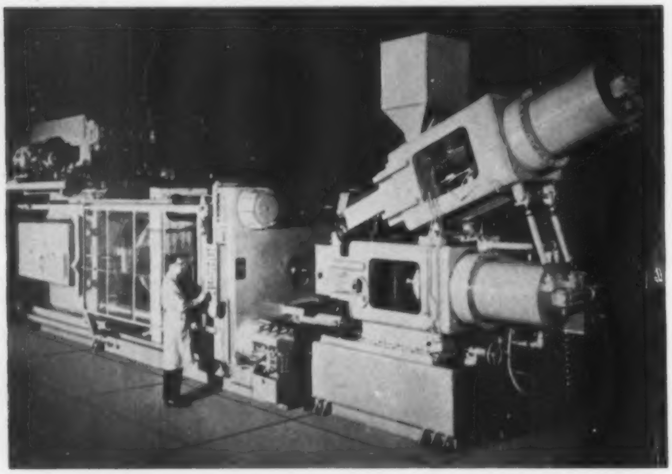
Properties	Unit	*Elrex* 100 Series	*Elrex* 200 Series	Test Method ASTM
Tensile Strength	psi	6800-7800	6500-7500	D-638
Elongation	%	1.5-3.0	1.0-2.5	D-638
Tensile Modulus	psi	450,000-480,000	470,000-500,000	D-638
Flexural Strength	psi	9000-12000	8000-11500	D-790
Izod Impact ½" x ½"	ft. lbs. per in. notch	.35-.50	.30-.45	D-256-56
Hardness	Rockwell "M"	70-80	70-80	D-785-51
Deflection Temperature Under Load	°F at 264 psi fiber stress	175-182	170-178	D-648-56
Thermal Expansion	in./in.	.0003-.0004	.0003-.0004	D-696-44
Specific Gravity	—	1.05	1.05	D-752-50

The above data represent average laboratory values by the methods indicated and should be so considered. Since processing variables contribute heavily to product performance, this information should serve only as a guide. To the best of our knowledge, the data are accurate.

REXALL CHEMICAL COMPANY
P.O. Box 37, Paramus, N. J.
A Division of Rexall Drug and Chemical Company

NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*



Giant preplasticating injection press

Designated Model 2500-P-300, this HPM 300-oz. injection machine has a preplasticating cylinder of advanced design. A three-way rotary valve for material control and other mechanical devices are combined to optimize speed, control of shot weight, and melt uniformity. Clamp pressure is 2500 tons. Maximum injection rate is 6500 cu. in./min. The platens will accommodate molds up to 48 by 83½ inches. Clamping is hydraulic and the clamp stroke is 60 inches. Maximum daylight opening is 106 in.; 120 in. with ejector box removed. The machine is powered with 290 hp. and individual hydraulic systems are provided for the clamp and injection ends of the machine. Base dimension is 12 by 36 feet. *The Hydraulic Press Mfg. Co., Div. of Koehring Co., Mt. Gilead, Ohio.*

Mold spotter for speedy repairs and safety

Increased safety and speed in the building and repair of plastics molds is now offered by the Tilt-A-Die mold and die spotter. Mold halves are fastened to a stationary upper platen and a vertically movable lower platen in the machine. Both platens are free to roll laterally on ball bearings so that the mold halves can be positioned outboard on opposite sides of the unit. The platens may then be tilted hydraulically so that the mold can be worked on conveniently. Each platen is positively located and mechanically locked at the desired angle for spotting-in. After spotting-in operations have been completed, the mold halves are returned for repeat bluing-in procedures. Up to 130 tons may be applied to the mold to simulate operating mold pressures. Daylight between the platens is 33 in.; molds up to 30 in. wide by 50 in. long can be accommodated. *Sanders Tool & Production Co., 4030 Fitch Rd., Toledo 13, Ohio.*

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

Color blending hopper loader

Designated as the 600 Series, these fully automatic hopper loaders will combine natural material and color concentrate in a predetermined ratio and then feed the mix to the machine hopper. Two models are available. Model 600 will deliver 300 lb./hr. of mixed material, while Model 650 will handle 400 lb./hr. The former model requires a plant air supply; the latter has its own motor and blower and requires only a small supplemental air supply. Natural material is transferred from the shipping container to a receiving hopper on the unit and is then proportioned volumetrically with the color concentrate which comes from another hopper on the unit. The ratio of natural material to color concentrate can be adjusted from 6:1 to 25:1. Unit can be operated manually while the proper ratio for the color effect desired is being determined. Controls on the feed hoppers prevent unmixed materials from being fed to the machine hopper. *Whitlock Associates Inc., 21655 Coolidge Hwy., Oak Park 37, Mich.*

Film-scrap grinder

Designed primarily for the granulation of roll-fed scrap film and sheet as thin as 0.001 in. and up to 48 in. wide, the cutter has extremely accurate knife clearances. Clearances can be held to within 0.003 inch. The rotor cutting center is 20 in. in diameter. Rotating knives are "shear cut" and firmly wedge-locked into position on the rotor. An integral knife grinder sharpens the knives on the machine. *Sprout, Waldron & Co., 130 Logan St., Muncy, Pa.*

Foam tester

This portable instrument is designed to measure the indentation compression or firmness of elastomeric foams such as those made of polyurethane and vinyl. This is done by measuring the weight required to compress the surface of the foam by a fixed amount. The results may then be expressed in regulation ASTM, RMA and SPI units. Use of the instrument requires that a small slit be made through the foam being measured. This slit is ordinarily not damaging and is usually unnoticeable after the test is complete. *Testing Machines Inc., 72 Jericho Tpke., Mineola, N. Y.*

(More on page 50)

 (From page 48)

Blow molder

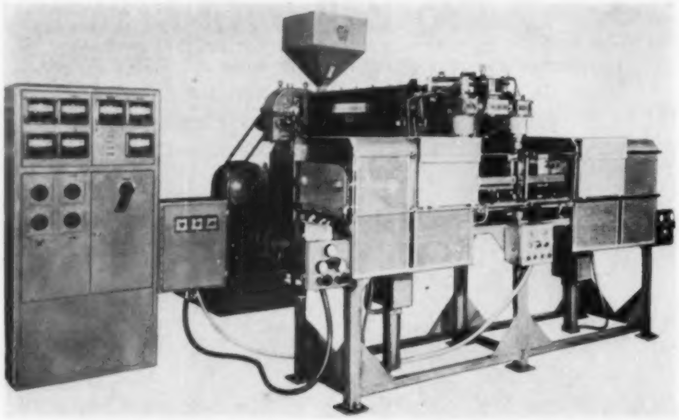
Trademarked Meter-Master, these blow-molding machines have toggle-action clamping and high-pressure hydraulic parison extrusion accumulators. Units are available in 2-, 4-, and 8-station models and can be used to mold simultaneously different products up to 8 in. in diameter. Machines may be set to run only one mold station or all stations at the same time. Molten plastic is supplied from an extruder which is used to fill the parison-forming accumulators for the rapid extrusion of parisons. Use of the accumulators allows the extruder to run continuously. Clamping and blowing operations alternate from station to station being fed from a single extruder. The toggle-action clamp permits rapid closing of the molds while cushioning the impact of full clamp force. *Auto-Blow Corp., 105 Meadow St., Fairfield, Conn.*

Thermoset injection machine

Tradenamed Duroplast, this machine will handle thermoset molding compositions which can be fed as a paste or putty. In operation, the viscous plastic material is loaded at room temperature into the injection cylinder, then injected into a hot mold. The injection system feeds the material into a rotary mold table section which can accommodate from two to six molds. As each mold is filled, it moves away from the nozzle and the material cures in the hot mold as it makes its way to the ejection station. Speed of the rotating table must be coordinated with the curing characteristics of the material to allow sufficient time for complete cure of the material prior to ejection. Platen temperatures can be controlled to within $\pm 1°$ C. All electrical machine controls are housed in a separate cabinet. Additional specifications are shown in the table. *Maschinenfabrik Georg Seidl KG, München 54, Germany.*

Specifications: Duroplast injection machines

Injection pressure range, p.s.i.	440 to 2000
Injection speed range, sec./shot	5 to 20
Shot size range, oz.	⅓ to 35¼
Number of mold stations	2 to 6
Clamp force, tons, max.	330
Maximum daylight, in.	14
Maximum molding area, in.	16 by 20
Heater power, kw.	10
Approx. floor space, required, ft.	10 by 13

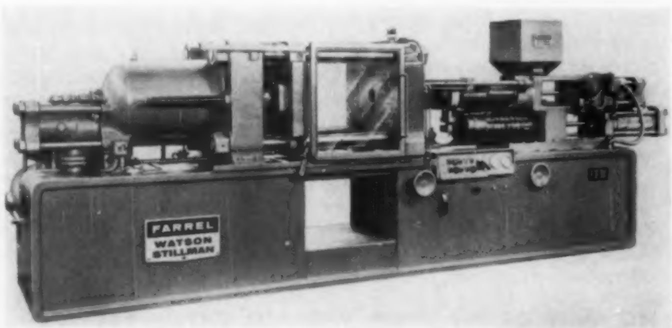


Film fabricator prints and welds from roll stock

The Thermatron automatic silk screen printer and welder machine is capable of producing printed and heat-sealed plastic film products in a continuous fashion using a mill roll feed. The unit will print the web, make the required seal in precision register with the printed image, index, and then continue to the next cycle. Equipment includes feed, power unwinds, and dance roller sections for mounting multiple rolls of material. The web is tensioned for accuracy in registration and indexing. The silk-screening station has a vacuum device for film hold-down to insure the sharpness of printing. After drying in air between stations, the web is guided laterally into exact register for heat sealing. Any adjustment in register or indexing can be made while the machine runs automatically. Safety cutouts shut down the unit in case of malfunction. Typical production rate for book covers, 12 by 21½ in., is 24 covers per minute. *Thermatron, Div. of Willcox & Gibbs Sewing Machine Co., 214 W. 39th St., New York, N. Y.*

Preplasticating injection molding machine

The Farrel Watson-Stillman P-30-300 has a maximum shot weight of 30 oz. and will plasticate styrene at rates up to 140 lb. per hour. Maximum injection pressure on the material is 20,000 p.s.i.; injection rate is 1090 cu. in. per minute. Clamping stroke is 18 in.; maximum clamp force is 300 tons. Maximum die size is 20½ in. by 36 inches. Daylight opening is 30 inches. The unit may be operated manually, on automatic single cycle, or fully automatically with low-pressure closing. A special pumping system provides shock-free operation at high speeds. The preplasticating cylinder has an internally heated torpedo and the injection bracket and plunger are water cooled. Clamp, injection, and die-opening speeds are controlled and adjustable. Nozzle shut-off and positive stop are available for this injection machine if they are desired. *Farrel-Birmingham Co. Inc., Watson-Stillman Press Div., 565 Blossom Rd., Rochester 10, N. Y.*



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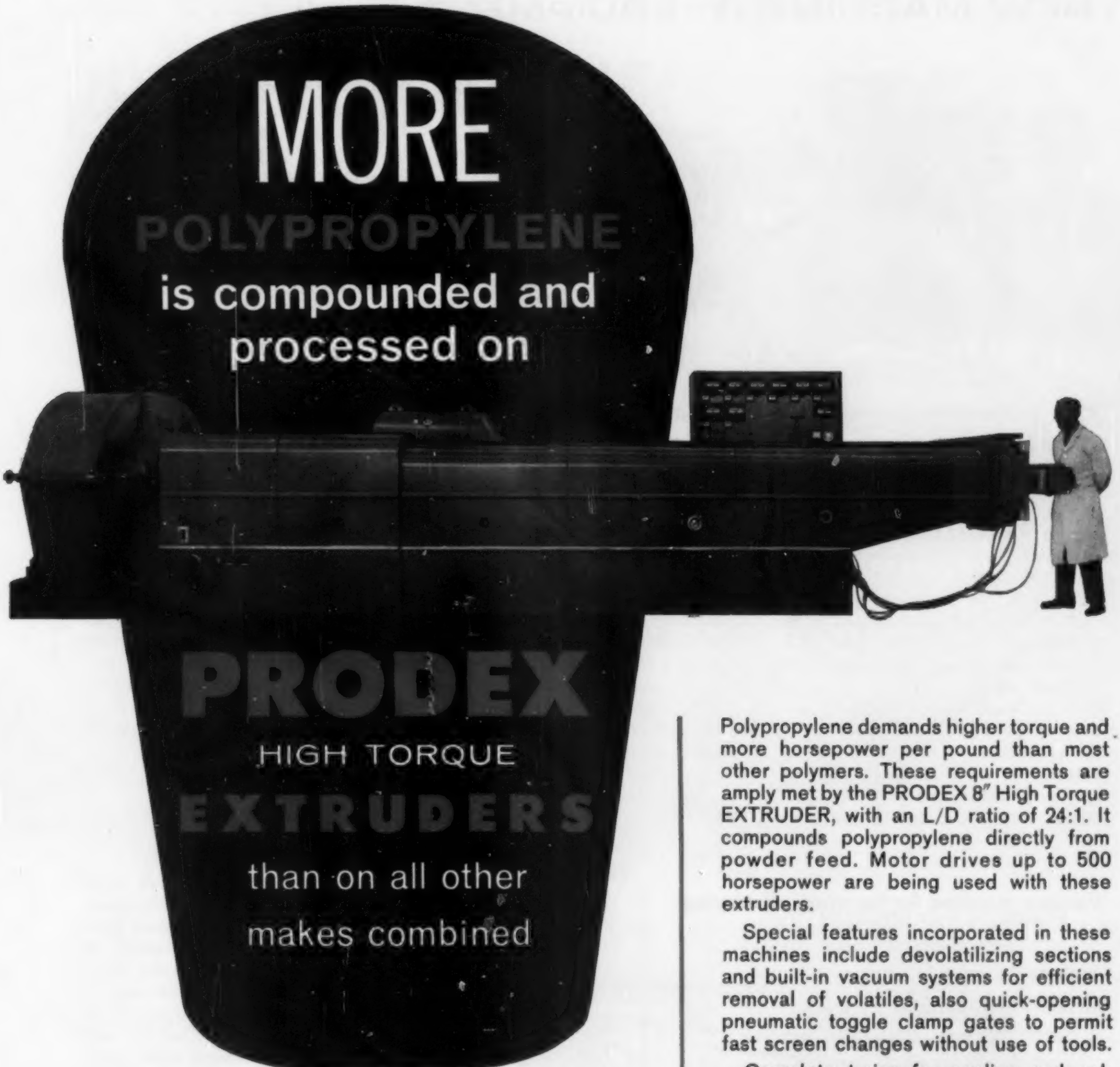

Polypropylene demands higher torque and more horsepower per pound than most other polymers. These requirements are amply met by the PRODEX 8" High Torque EXTRUDER, with an L/D ratio of 24:1. It compounds polypropylene directly from powder feed. Motor drives up to 500 horsepower are being used with these extruders.

Special features incorporated in these machines include devolatilizing sections and built-in vacuum systems for efficient removal of volatiles, also quick-opening pneumatic toggle clamp gates to permit fast screen changes without use of tools.

Complete trains for cooling and pelletizing the product are available. Explosion-proof extruders for hazardous atmospheres can be supplied.

Many advantages are derived from the combined operation of Prodex extruders with the Prodex-Henschel mixer.

Let us demonstrate to you in our customer service laboratory . . . with your own materials . . . the reasons why Prodex extruders and mixers are the most widely used in the industry. Write or phone for an appointment.

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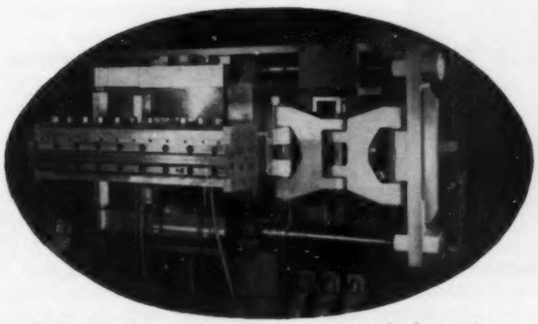

Photo above shows quick-opening pneumatic toggle clamp gate.

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Blow molder with interchangeable clamping units

The Blow-O-Matic blow molder is of the rising-mold type and is designed for continuous production. Three components form the entire machine, namely, a molding unit, a power pack containing the controls and hydraulic pressure supply, and an extruder which produces the parisons for the molding unit. The molding unit's flexibility is enhanced by the fact that interchangeable mold clamping units of three different sizes can be used with the same base unit. The three sizes of mold tables are suitable for the production of blown items with volumes of ½, 2½, and 5 gal., respectively. Tables can be changed in 30 min. simply by loosening 18 screws, replacing the table and retightening the screws. Depending on the table used and the size of the part being made, from one to five dies can be used. Machine controls are such that 11 different types of cycles can be set up on the unit. Air at 150 p.s.i. at a rate of 5 cu. ft./min. is required for blowing and ejection purposes; all other motions are hydraulically operated. Dry cycles vary from 250 to 3000/hr., depending on which size table is being used. All operations can be set to work manually, semi-automatically or fully automatic. *Danish Plastics, Copenhagen, Denmark.* In U.S.: *The Rainville Co. Inc., 839 Stewart Ave., Garden City, N. Y.*

Vacuum machine for forming, packaging

Designated Model V, this machine is designed for both plastics forming and packaging applications. It can do conventional vacuum forming, vacuum drape forming, or drape plug assist forming in addition to providing three positions for skin packaging. Material may be fed manually or automatically using roll and sheet feeders which are available as accessories. Electrical wiring for the accessories is provided with all units in the Model V series. Controlled 3 kw./FT2 heaters with aluminized reflector panels are provided. Unit has a completely adjustable drape stroke of 16 in. and comes in four standard mold sizes ranging from 20 by 25 in. to 42 by 72 inches. *Pacific Plastic Machinery Inc., 3443 S. Lawndale St., Chicago 23, Ill.*

Resin dispenser

The Micro-Shot machine is designed to deliver shot volumes from less than 1 to 20 cc. and is particularly suited for resin casting in electronic component manufacture. Operation is electro-pneumatic and a special metering mechanism is used. Resin and activator components are forced out of separate feed vessels by air pressure through the feed lines and inlet valves on the metering cylinder. The components are accurately proportioned on each shot since the two metering inlets are controlled by a common ratio arm which is pivot-mounted. *Automatic Process Control, 1170 Morris Ave., Union, N. J.*

Hand welder

The Model 14-HW hand welder and tacker is especially designed for thermoplastics such as polyethylene, polypropylene, PVC, and others, The unit is supplied with a 320-w. heating element, one round tip, one tacker tip, and a needle valve for hot air control. The welder is stainless steel throughout, has 16 ft. of air hose, ready to plug into a 115-v. a.c. outlet. *Kamlar Products Co., Norwood, Mass.*

Foam cutter

The Horizontal Multi-Cut machine will slice a block of plastic foam into as many as 18 sheets in a single pass. The block is fed, by means of a powered conveyor, into a cutting system consisting of from 1 to 18 horizontal hot wires. The number of wires used will depend on the thickness and the number of sheets desired. Wires may be placed at angles to cut wedge-shaped pieces. The unit will handle foam blocks up to 69 in. wide, 37 in. high, and up to 20 ft. long if idler rollers are added to the end of the conveyor. Since the foam block is not under compression while being cut, cuts are clean and accurate. *Falls Engineering & Machine Co., 1734 Front St., Cuyahoga Falls, Ohio.*

Dicer knife

A carbide bed knife has been developed for use on Cumberland Stair Step Dicers. It has been designed to increase the production life of such knives up to 15 times that of the ordinary knife between sharpenings. The carbide knife has a cutting life of from 300,000 to 1 million lb. of vinyl, depending on the type and abrasiveness of the filler material. It can be resharpened over 25 times. *Keen-Edge Carbide Cutter Corp., 215 Clay Ave., Roselle Park, N. J.*

(More on page 54)

NEW MACHINERY-EQUIPMENT

(From page 52)

Automatic preplasticating injection machine

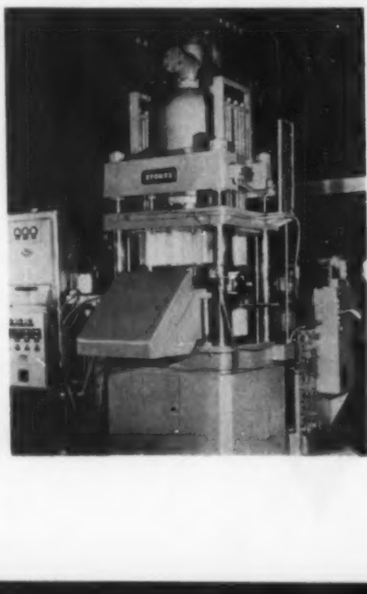
Completely automatic in operation, the Imperial Mini-jector Model No. 80 2-oz. injection molder is designed to handle molds 9⅞ by 8 in. in size, but can handle molds up to 11 by 8 inches. Plasticating capacity is 25 to 30 lb. per hour. Dry cycle time is 5 sec. without packing stroke and 7 sec. with packing stroke. Two-point toggle provides about 42 tons of clamp force. Unit has provision for interchangeable cylinders and is designed for rapid mold changes. Two-zone cylinder heat control and an adjustable clamp stroke are provided. Optional accessories include: nylon nozzles, mold chilling and heating systems, water-cooled plunger, weigh-feeder, and adjustable plunger speed. *Newbury Industries Inc., Newbury, Ohio.*

Transfer-molding press with automatic speed

With the 200-ton Stokes Model 741 AT automatic press for transfer molding, the operator need only pour cold preforms into the press hopper and cart away finished parts and scrap, culls, and runners. One operator can handle six presses. The preforms are fed automatically from a vibratory bowl to an automatic stacking and counting device (left in photo). The number of preforms required to make a single mold charge, from one to 10 depending on the thickness of the preform and the mold charge, can be selected by a dial. The total preform charge is then automatically conveyed into a LaRose preheater. When heating is complete (in 10 to 30 sec.) the hot stack is conveyed to the transfer pot of the mold. In molding, clamp and transfer pressures may be independently controlled. After molding, a system of trays and combs in combination with a positive ejection system separates the parts from the cull and runner system and ejects both into different bins. The press is also designed to interrupt the press cycle in the event of short shots or overcharges in the mold. Other specifications shown below. *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

Specifications: Stokes press

Clamp capacity, tons	200
Clamp stroke, in.	16
Clamp ram speed, in./min.	
Closing	250
Intermediate	45
Pressing (adjustable)	0 to 17
Opening	250
Ejection strokes, in.	
Top, 3; bottom, 4⅞	
Ejection pressures, tons	
Top, 5; bottom, 12	
Daylight, in. Open, 38; closed,	22
Standard mold size, in.	30 by 24
Bottom transfer capacity, tons	40
Bottom transfer stroke, in.	10



Machinery in brief

▶ OlsenMark Corp. announces it is now making a complete line of power presses for use in embossing, creasing, heat sealing, swedging, stacking, and other operations. Presses are supplied in three pressure ranges; ½, 3½, and 4 to 7 tons. *OlsenMark Corp., 124-132 White St., New York, N. Y.*

▶ The Thermo Electronic Multi-Point Controller can be used for automatic two-position control for up to 10 separate processes. The instrument can also be used as a single point controller, a five-point, three-position controller, and a manual balance indicator. Any points not being used for control of a multi-temperature process can monitor other processes. *Thermo Electric Co. Inc., Saddle Brook, N. J.*

▶ *The Header Tool Co., 24474 Telegraph Rd., Southfield, Mich.*, is now manufacturing a complete line of injection machine replacement nozzles for all makes of machines.

▶ The American Rotary Tools Co. Inc. has acquired all national sales distribution rights to the Dot Welder formerly sold by the Mid-States Welder Mfg. Co. The machine is used to repair plastic molds by fusing small metal pellets into scratches, dents, and cavities. *American Rotary Tools Co. Inc., 159 Great Neck Road, Great Neck, N. Y.*

▶ A pilot-size vertical planetary mixer, suitable for use in vinyl dry blend work has a capacity of 5 gal. and will handle up to 50 to 70 lb. of material per batch. *Chemical Machinery Div., Baker Perkins Inc., 1000 Hess, Saginaw, Mich.*

▶ A new auxiliary hopper for B & J Marvel Series granulators, rectangular in shape, permits the feeding of flat and irregularly shaped materials directly into the cutting chamber. It is used in addition to the regular hopper for special work. *Ball & Jewell Inc., 22 Franklin St., Brooklyn, N. Y.*

▶ A machine has been developed which will imprint opposite sides of a plastic part simultaneously. Printing is done by the hot stamp method. Typical production rate is 500 pieces per hour. *Ackerman-Gould Co. Inc., P. O. Box 188, Oceanside, N. Y.*

Correction

"Multi-station rotary thermoformer" (MPl, Jan. 1961, p. 52): Heater supply is 42 kilowatts.—**End**

WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.

General

General Electric Co. bets on polycarbonate resins. Chem. Eng. Progress *56,* 104 (Oct. 1960). General Electric Co. has spent 11 million dollars on research, development costs, and a plant at Mt. Vernon, Ind. to produce polycarbonate resins. The properties as well as the economics of polycarbonate resins are given.

Materials

MPI'S 'HI MOD' glass fiber material opens new concept of motor cases. J. Judge. Missiles and Rockets *7,* 23-24 (Dec. 12, 1960). Unidirectional glass fiber laminates made from a resin-impregnated parallel-glass-fiber tape microseconds after the tape is formed has a flexural strength of 250,000 p.s.i., a flexural modulus of 10.4 million p.s.i., and 96.5% strength retention after a 2-hr. boil in water.

Evaluation of dialkyl 11-phosphonoundecanoates and P, P-dialkyl 9(10)-phosphonostearates as plasticizers for vinyl chloride polymers. D. Swern, W. E. Palm, R. Sasin, and L. P. Witnauer, J. Chem. Eng. Data *5,* 484-85 (Oct. 1960). Two new classes of long-chain phosphorus organic compounds are suitable for use as plasticizers for polyvinyl chloride, comparing favorably with present commercial plasticizers.

For outdoor vinyls. Chem. Week *87,* 46, 48 (Dec. 10, 1960). A new epoxy plasticizer-stabilizer, di-isodecyl 4,5-epoxy tetrahydrophthalate, for PVC films increases service life outdoors and resistance to heat.

Silicon-nitrogen bond may be good backbone for polymers. Chem. Eng. News *38,* 47-48 (Nov. 14, 1960). Inorganic polymers based on Si-N bonds have been made. They have high heat resistance, could lead to coordination polymers, and they also are water sensitive.

Molding and fabricating

Vacuum forming of biaxially oriented polystyrene. A. S. Matthews and G. Hulse. Brit. Plastics *33,* 463-67 (Oct. 1960). Biaxially oriented polystyrene has many properties that make it desirable as a packaging material. Film or sheet material of 0.003 in. thickness, or greater, may be shaped by pressure or vacuum forming. Emphasis is given to vacuum forming techniques involving special properties of polystyrene that make its handling different from other thermoplastics.

Effect of pressure on the cohesion of polypropylene. Iu. V. Ovchinnikov, K. S. Minsker, and L. A. Igonin. Vysokomolekuliarnye Soedineniia *2,* 306-09 (Feb. 1960). The conditions for the formation of transparent specimens by compression molding of polypropylene powders over a large range of temperatures and pressures were investigated. Whatever the pressure, no intergrowth of polymer particles with the disappearance of physical boundaries between them takes place at temperatures below the melting point (169° C.) of polypropylene. The formation of transparent articles is possible in the temperature and pressure regions bounded by the upper branch of the pressure-temperature curve. The region is above the polypropylene melting temperature. The application of high pressures raises the melting temperature. Articles molded at 200° C. and pressures above the upper limit (above the limit of formation of opaque materials) possess inferior physicomechanical properties as compared to those formed at pressures below this limit.

Applications

Copolymer film shipping bags. R. J. Martinovich and R. Doyle. Modern Packaging *34,* 131-5, 206, 209 (Nov. 1960). Bags made of modified ethylene copolymer tubular film 5 to 7 mils thick are reported to have better performance characteristics than 10-mil-thick low-density polyethylene bags. Various physical properties of this material are compared to those of materials commonly in use for shipping bags.

Properties

Factors affecting bursting behavior of hard PVC pipe at elevated temperatures. A. A. Van der Wal. Plastics (London) *25,* 361 (Sept. 1960). The relationships between heat distortion, burst strength, and water absorption of rigid PVC pipe were studied. Stress-time curves were obtained at 60° C. for pipe having heat distortion temperatures of 60, 65, and 70° C.

Adhesion capacity of dry, small-particle-size materials. W. Batel. Chem. Ing. Tech. *31,* 343-45 (May 1959). The adhesion and cohesion of dry, small-particle-size materials often occurs as a result of adsorption layers. With the elimination of these layers the adhesion capacity disappears except when this is caused by electrostatic charges or directly by the field force of the molecules in the solid surface. The friction factor increases with the particle size and with the elimination of the adsorption layers.

Testing

Colorimetric precision method of determining end groups. S. R. Palit. Kunststoffe *50,* 513-14 (Sept. 1960). A qualitative test to identify end groups in polymers is based on the colors formed when they react with cationic and anionic soaps.

Ultrasonic method for quantitative determination of the components of polyethylene-polypropylene mixtures and of ethylene-propylene copolymers. S. P. Kabin and O. G. Us'yarov. Vysokomolekuliarnye Soedineniia *2,* 46-50 (Jan. 1960). Results are presented of a study of the mechanical losses occurring at longitudinal ultrasonic vibrations of 2 mc./sec. in polyethylene-polypropylene mixtures and ethylene-propylene copolymers with various concentrations of the components. For polyethylene-propylene mixtures within the temperature range of −60 to +80° C. two regions of mechanical relaxation losses, characteristic of each of the components, are observed at −60 and −45° C. The losses in this region are proportional to the propylene concentration within the limits ranging from 0 to 40 percent. From the nature of the temperature dependence of the mechanical losses mixtures can be detected.

Publishers' addresses

British Plastics: Iliffe and Sons Ltd., Dorset House, Stamford St., London SE1, England.

Chemical and Engineering News: American Chemical Society, 1155 Sixteenth St., N. W., Washington, D. C.

Chemical Engineering Progress: American Institute of Chemical Engineers, 120 E. 41st St., New York 17, N. Y.

Chemical Week: McGraw-Hill Publishing Co. Inc., 330 W. 42nd St., New York 36, N. Y.

Chemie-Ingenieur-Technik: Ziegelhauser Landstr. 35, Heidelberg 17A, Germany.

Journal of Chemical Engineering Data: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.

Missiles and Rockets: American Aviation Publications, 1001 Vermont Ave., N. W., Washington 5, D. C.

Modern Packaging: (New address): 770 Lexington Ave., New York 21, N. Y.

Plastics (London): Temple Press Ltd., Bowling Greene Lane, London EC1, England.

Vysokomolekuliarnye Soedineniia: Academy of Science of U.S.S.R., Moscow, Russia.—**End**

*Reg. U.S. Pat. Off.

U. S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U.S. Pats., Nov. 15, 1960

Calendering. I. Curletti (to Montecatini). 2,959,811.

Plastisol molding. T. A. Miller and T. A. Miller Jr. 2,959,820.

Crosslinking agent. G. Kolb (to Bayer). 2,959,821.

Nonmetallic armor plate. P. V. O. Bjorholm. 2,960,424.

Acrylamides. D. J. Pye (to Dow). 2,960,486.

Polyolefins. J. W. Tamblyn and W. V. McConnell (to Eastman). 2,960,488.

Polycondensate films. A. J. Conix (to Gavaert). 2,960,493.

Polysulfide-spirobi (m-dioxane) polymers. H. A. Stansbury Jr. and H. R. Guest (to Union Carbide). 2,960,495.

U.S. Pats., Nov. 22, 1960

Foamed plastic. G. E. Jodell (to Electrolux). 2,960,720.

Blister forming. P. Freeman. 2,960,-722.

Electrolytic polymerization of phenol. D. S. McKinney and J. P. Fugassi (to American Marietta). 2,961,384.

Styrene-allyl alcohol copolymers. E. C. Chapin (to Monsanto). 2,961,423.

Acrylylphenol copolymers. V. A. Engelhardt and H. E. Winberg (to Du Pont). 2,961,426.

Polyacetal-polyisocyanate polymers. E. Muller and G. Braun (to Bayer and Mobay). 2,961,428.

Sodium ethylene sulfonate copolymers. A. Kutner (to Hercules). 2,-961,431.

U.S. Pats., Nov. 29, 1960

Centrifugal molding. A. D. Pinotti (to Kimball Glass). 2,961,703.

Rain-repellent compositions. J. M. Fain, E. E. McDonnell, and S. Miller. 2,962,390.

Structural panel. W. C. Jones (to Bell Aerospace). 2,962,403.

Composite structure. E. Ludlow and G. E. Wintermute (to Arvin). 2,962,-409.

Ethoxyline resins. L. S. Kohn and A. H. Horner (to General Electric). 2,962,410.

Flameproof polyethylene. G. B. Feild (to Hercules). 2,962,464.

Polyalkylvinyl ethers. R. M. Verberg (to General Aniline). 2,962,476.

Vinyl levulinate. R. H. Leonard and C. Bordenca (to Heyden). 2,962,478.

Fluorodiene-styrene copolymers. F. J. Houn (to 3M). 2,962,484.

Acetylated styrene polymers. H. A. Walter and J. A. Blanchette (to Monsanto). 2,962,485.

U.S. Pats., Dec. 6, 1960

Laminated sponge. F. E. Henriksson (to United Shoe). 2,962,743.

Plastic mills. A. Hale and C. L. Conley Jr. (to Blaw-Knox). 2,962,753.

Hollow plastics. C. J. Politis (to Illinois Tool). 2,962,758.

Injection molding. M. Maccaferri. 2,962,759.

Phosphorus-containing polyesters. H. Coates (to Albright & Wilson). 2,-963,451.

Polyvinyl alcohol. I. Pockel (to Cambridge Industries). 2,963,461.

Furane resins. M. T. Harvey and P. L. Rosamilia (to Harvel). 2,963,463.

Polyspiranes. S. M. Cohen and E. Lavin (to Shawinigan). 2,963,464.

Polyurea polymers. G. J. M. van der Kerk (to Handel en Verkeer). 2,963,-465.

Dichlorourea-diamine resins. C. S. Grove Jr. and V. T. Stannett (to W. R. Grace). 2,963,466.

U.S. Pats., Dec. 13, 1960

Bottle closures. A. Brandes, A. Christmann, and H. Willersinn (to Bender). 2,963,738.

Extrusion. M. O. Longstreth and J. E. Tollar (to Dow). 2,963,741.

Polytetrafluoroethylene tubing. A. H. Haroldson, J. S. Taylor, and W. F. Cann Jr. (to Continental Diamond Fibre). 2,964,065.

Photopolymerization. L. Plambeck, Jr. (to Du Pont). 2,964,401.

Ethylcellulose chlorophthalate. R. H. Talbot and W. J. Priest (to Eastman). 2,964,405.

Films. A. L. Van Stappen (to Du Pont). 2,964,423.

Paper laminates. U. Holtschmidt (to Goldschmidt). 2,964,426.

Laminating. B. M. Mikulis and H. W. Wegener (to Sanders). 2,964,436.

Molding. G. B. Hansen (to Polyplex). 2,964,442.

Mounting samples. J. E. Dereich (to Diamond Alkali). 2,964,443.

Laminated propellor. R. R. Lynn (to Bell). 2,964,444.

Polymer-metal process. W. A. Hosmer (to General Aniline). 2,964,447.

Irradiation polymerization. T. W. Findley (to Swift). 2,964,454.

Irradiated polyethers. B. Graham (to Du Pont). 2,964,455.

Polyethylene. L. Ter-Minassian (to Houilleres du Bassin du Nord). 2,964,458.

Alkyd resins. R. F. Leary and L. W. Bowman (to Esso). 2,964,482.

Polymer blend. A. L. Johnson, M. Morf, and J. K. Whiteley (to Canadian Industries). 2,964,483.

Crosslinked reaction products. T. W. Findley and J. L. Ohlson (to Swift). 2,964,484.

Color stabilization. A. J. Martinelli (to General Aniline). 2,964,485.

Polybutadiene. L. H. Howland and W. W. White (to U. S. Rubber). 2,964,490.

Phenolic resin compositions. A. F. Rylander, H. A. Vogel, and R. F. Roach (to Pittsburgh Plate). 2,964,-491.

Epoxy resin. J. D. Murdock and G. H. Segall (to Canadian Industries). 2,964,492.

Polyolefins. G. R. Lappin and W. V. McConnell (to Eastman). 2,964,494.

Light-stable polyolefins. G. C. Newland and J. W. Tamblyn (to Eastman). 2,964,495-6-7.

Silicic ester polymers. F. Weigel and R. Schwarz (to Siemens). 2,964,499.

Formaldehyde polymers. S. H. Jenkins Jr. and J. O. Punderson (to Du Pont). 2,964,500.

Glycol carbonate polymers. G. M. J. Sarofeen (to Titmus Optical). 2, 964,-501.

Polymers. C. E. Wheelock (to Phillips). 2,964,502.

Polysulfides. G. D. Carpenter, G. Gregory, S. H. Kalfayan, and I. P. Seegman (to Products Research). 2,964,503.

Diene polymers. J. J. Drysdale (to Du Pont). 2,964,505.

Polymerization. J. E. Wicklatz and K. R. Mills (to Phillips). 2,964,506.

Fluoropolymers. W. H. Kuoth Jr. (to Du Pont). 2,964,507.—**End**

P807/O/A

One of several very large Guinness Clock signs made from 'Perspex' acrylic sheet by The Electric Sign Company Limited, Marshalsea Road, London, S.E.1., for A. Guinness Son & Co. (Park Royal) Ltd.

'Perspex' shows Guinness time by day and night

THERE'S no mistaking Guinness time when you see it on this huge sign—one of several made by The Electric Sign Company Limited. The whole sign including the letters and the clock face has been made from 'Perspex' acrylic sheet, to produce an attractive modern sign by day or, by internal illumination, a brilliant sign by night. 'Perspex' is a wonderfully versatile material for sign construction. It can be readily shaped and engraved. Mounting and inlaying present no problem. It can be easily shaped into letter forms and takes printing perfectly. And the smooth durable surface is easy to maintain and will stand up to bad weather conditions. For attractive signs that last, specify 'Perspex'.

'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

ICI

Imperial Chemical Industries Ltd., Plastics Division, Export Dept., Bessemer Rd., Welwyn Garden City, Herts., England.

U.S.A. Enquiries to: J. B. Henriques Inc., 521 Fifth Avenue, New York 17, N.Y.

Canadian Enquiries to: Canadian Industries Limited, Plastics Division, P.O. Box 10, Montreal, P.Q.

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MODERN PLASTICS'

THE EXCITING INTER-

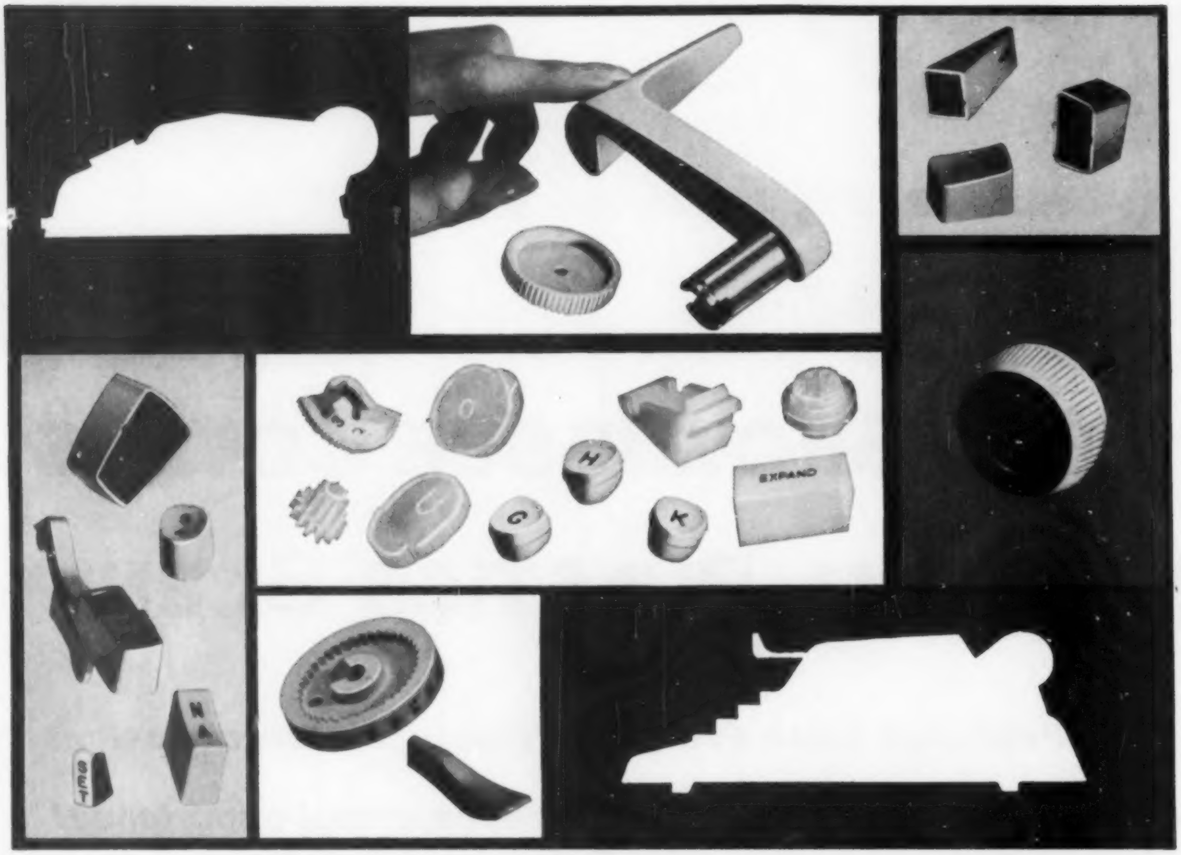
Great new developments forecast a major revolution in the <u>Wide World</u> of Plastics.

From many countries the world over come new applications, improved methods, designs and techniques which will provide a startling eye-opener for everyone throughout the entire plastics industry. Indeed, the world of plastics now transcends the limits formerly regarded as being somewhere between New York and California. That's why the May 1961 Modern Plastics Show Issue will be universal in scope, with critical focus of attention on this phenomena of the international evolution of plastics. This should be of prime concern to everyone in both segments of the field: the basic plastics industry—and the industrial end-user.

The two-continent coverage of the May Show Issue will provide complete information on all three shows—in New York—London—and Ghent, Belgium. It will serve the one and only 9th National Plastics Exposition in the U. S., June 5-9, '61, the show sponsored by the Society of the Plastics Industry at the New York Coliseum and co-featuring The SPI National Conference at the Hotel Commodore during the week of the Show.

Besides summarizing the world plastics picture from the standpoint of developments, changes, volume growth and production—Modern Plastics Show Issue will also carry a complete guide to the show. This includes a large diagrammatic layout of the exhibit areas, full schedule of conferences and special activities, program of the Plastics Conference and other news.

Modern Plastics will provide bonus readership through its presentation of detailed information on the British Plastics Show, June 21—July 1 at the Olympia, London, England . . . and the Euro Plastica Exposition, June 16-25 at the Palais de Floralies at Ghent, Belgium.



STOKES HIGH-SPEED INJECTION MOLDING PRESSES

earn big savings for Smith-Corona Marchant

With the aid of Stokes Injection Molding Presses, Smith-Corona Marchant is turning out from one-half to three-quarter million dollars worth of parts per year for typewriters, adding machines, calculators, teletypewriters, and other products.

Complete sets of typewriter and calculator keyboards are produced at the rate of 400 to 440 per hour by the four Stokes Model 703 Automatic Injection Molding Presses shown here. These versatile Stokes presses are used for both multi-color and metal-insert molding.

Key to these high production rates is Stokes nozzle shut-off and full pressure prepack design. This exclusive design feature reduces the production cycle by having the injection plunger and precompressed material ready to shoot into the mold the moment the press is closed.

Stokes vertical clamping system permits loading of inserts without the danger of their falling out during the molding operation. Unusually high clamping capacity gives full and complete closure so that no flash is formed on the insert part. Independently actuated knock-out pins provide slow, gentle ejection without reducing clamping ram speed.

Discover for yourself what Smith-Corona Marchant and other leading manufacturers have found to be the many cost and quality advantages of Stokes Injection Molding Presses. Write for Bulletin 203 which gives complete details on the Stokes Model 701 and 703. Be sure to ask for a Stokes production analysis on your particular application requirements.

Plastics Equipment Division

F. J. STOKES CORPORATION

5500 Tabor Road, Philadelphia 20, Pa.

STOKES

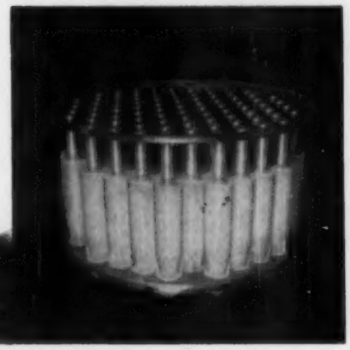
tiny cyclones cased in plastic safeguard road monster's mighty engines

Molding New Ideas Into Plastic

Injection-molded polypropylene helix vanes that swirl dust from the air are force-fitted directly onto aluminum tubes at the molding press.

Ridges on lower cyclone tube snap air-tight on baffle plate.

Cluster of vane and tube sub-assemblies in air cleaner.



Switch from metal to molded plastic cuts cost...simplifies assembly...resists corrosion...prolongs life of Donaclone air cleaner.

Severe dust concentrations encountered by many huge earth moving vehicles could ruin engines in a single day without efficient air cleaning equipment.

To protect these engines, Donaldson Company, St. Paul, Minn., builds a dry type air cleaner. Plastic helix vanes and cyclone tubes in the cleaner produce violent whirlwinds that blast 98% of the dust particles from the air stream. Paper filter traps remaining dust.

Original vanes and tubes were designed in metal; however, finishing costs were too high. So Minnesota Plastics was asked to mold a two-piece helix vane to fit the cyclone tube. Minnesota Plastics met the challenge. Going beyond the specifications, a one-piece helix vane and air tight cyclone tube were designed and found not only to be more functional, but reduced costs.

Compared to original metallic models, costs of the new cyclone tube were slashed *in half* and helix vanes were cut about *one-third*.

This is another example of the *extra* services, beyond molding plastics, that you can expect from Minnesota Plastics. If you are looking for fresh ideas to improve your products with plastic, write or wire Minnesota Plastics *first*. It could very well save you time, money and effort.

m p c

PIONEER MANUFACTURER OF NEW PRODUCTS IN PLASTIC

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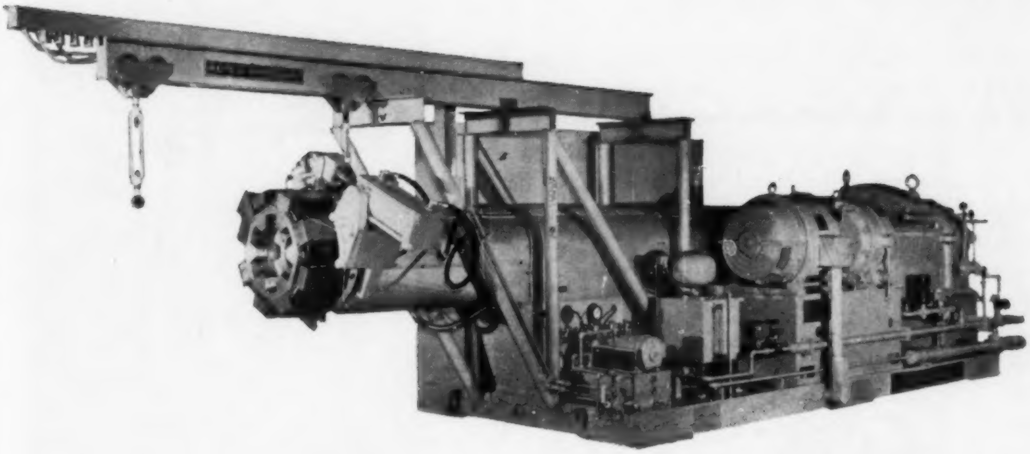


SETTING AETNA-STANDARD EXTRUDERS

DIES AND AUXILIARIES

manufactured by BLACK-CLAWSON

engineered by HALE and KULLGREN

The extensive line of plastic extrusion-coating machinery manufactured by The Black-Clawson Company, Dilts Division now includes Aetna-Standard extruder equipment which is widely used in coating and laminating polyethylene and other plastics to web materials.

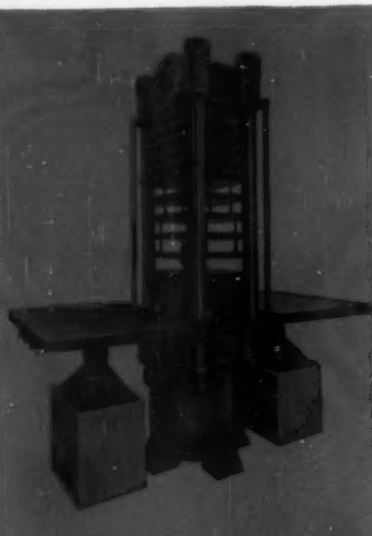
Hale and Kullgren Inc. has, for many years, been the engineering sales and service company for Aetna-Standard Extruders. Continuity of their valuable engineering experience and technical ability is provided through Black-Clawson's newly-formed Hale and Kullgren Plastics Dept. of the Dilts Division located in Akron, Ohio.

HALE and KULLGREN **PLASTICS DEPT.**
613 E. Tallmadge Ave., Akron, Ohio

BLACK-CLAWSON

Quality is never sacrificed

When you look at a new R. D. Wood press, you find every recent advance in press control and operation to meet the needs of today's automated production techniques. Yet there has been no sacrifice in basic design strength and rigidity so important to maintain continuous production runs. For example: the original model of the press shown below was built 25 years ago and is still in full operation. If you bought a Wood Press today, you'd receive the same fine quality which provides longer life . . . less maintenance. This is the type of service you expect when you buy a Wood Press.



R. D. Wood multiple opening, single ram, four-column type hydraulic platen press for laminating or processing rubber, plastic and composition sheets. Capacity—1200 tons; working pressure—1600 psi; 11 platens, 44" x 50" x 3½". For complete information, write the R. D. Wood Company, Public Ledger Building, Philadelphia 5, Pa.

R. D. WOOD COMPANY

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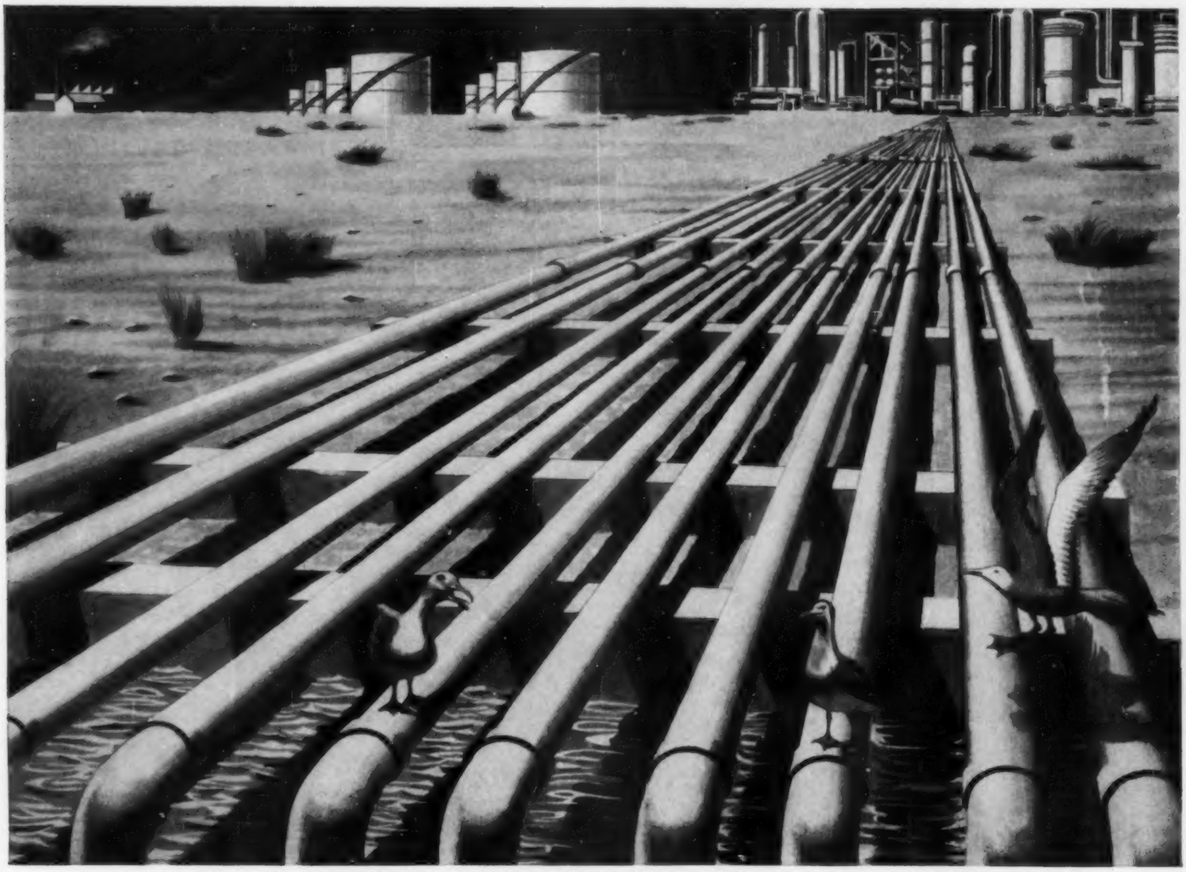

Low-cost way to make PVC rigids extra strong, tough, weather-resistant

Here's how National Lead helps deliver the PVC rigid quality you want, with four high-performance *basic lead* stabilizers... DYPHOS, LECTRO 78, TRIBASE and DS-207.

For excellent staying power through strenuous processing, choose from these four stabilizers. The right ones can give your resins the best possible tensile, impact and rupture strengths. You get the strongest rigids at low stabilizer cost.

- **DYPHOS®** offers the highest heat stability of the group. It provides the best weather resistance available in any stabilizer.
- **LECTRO 78®** provides heat stability comparable to DYPHOS, plus good weather resistance . . . at generally lower processing costs.
- **TRIBASE®** is the most economical primary stabilizer of the three. In suitable applications, it combines good heat stability with fair weather resistance.
- **DS-207®** improves the performance of these stabilizers, and should be used with each one. Since DS-207 is a lubricating stabilizer, the quantity used is usually governed by lubrication requirements. Often, it's supplemented by lubricants of other types.

Take advantage of the outstanding properties that these *basic lead* stabilizers will give your rigid pipe, sheet or structurals. You'll be pleased with the product uniformity you get with National Lead's quality-controlled stabilizers. You'll like the constant single-phase lubrication of DS-207. And you can forget dry blend or odor problems in production!

For helpful detailed information on these stabilizers, fill in and mail the coupon below.

NLC

National Lead Company, *General Offices:* 111 Broadway, New York 6, N.Y. KC-6293

In Canada: Canadian Titanium Pigments, Limited, 1401 McGill College Avenue, Montreal

Gentlemen: Please send data sheets on **DYPHOS, LECTRO 78, TRIBASE** and **DS-207** basic lead stabilizers.

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***Chemical Developments* of National Lead Company**

General Offices: 111 Broadway, New York 6, N.Y.


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How unseen polyethylene guards

Polyethylene coating provides an economical means of adding extra protective qualities, plus heat-sealability when needed, to packaging materials such as paper, paper board, cloth, cellophane, foil, etc. An ultra-thin coating of Spencer "Poly-Eth" 1018 seals moisture in or out of your package and permits a tight, heat-seal closure.

Up To 30% Faster Production At Lower Coating Weights

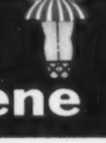
with new Spencer "Poly-Eth" 1018 Coating Resin

The makers of the 3 famous brands on the opposite page rely on polyethylene-coated packaging materials to protect the quality of their products. So do hundreds of other packagers—and the list is growing every month.

And now, Spencer Chemical Company introduces a superior new polyethylene coating resin called "Poly-Eth" 1018 that offers greater coating efficiency and economy than ever before possible.

In actual commercial use by Spencer customers, "Poly-Eth" 1018 permitted up to 30% faster production at lower coating weights than any other competitive coating material available. For example, with Spencer "Poly-Eth" 1018, 40-pound Kraft paper was successfully coated using as little as 1.2 pound of resin per ream at 900 feet per minute. Under identical conditions, the next best competitive polyethylene required 3.7 pounds of resin per ream, and its maximum coating speed was only 550 feet per minute.

If you make, sell or use coated packaging materials, it will pay you to find out how "Poly-Eth" 1018 can fit your needs. Spencer Technical Service representatives are available to help you work out production details. For further information, write Spencer Chemical Company, Dwight Building, Kansas City, Missouri.



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POLY®PRO POLYPROPYLENE

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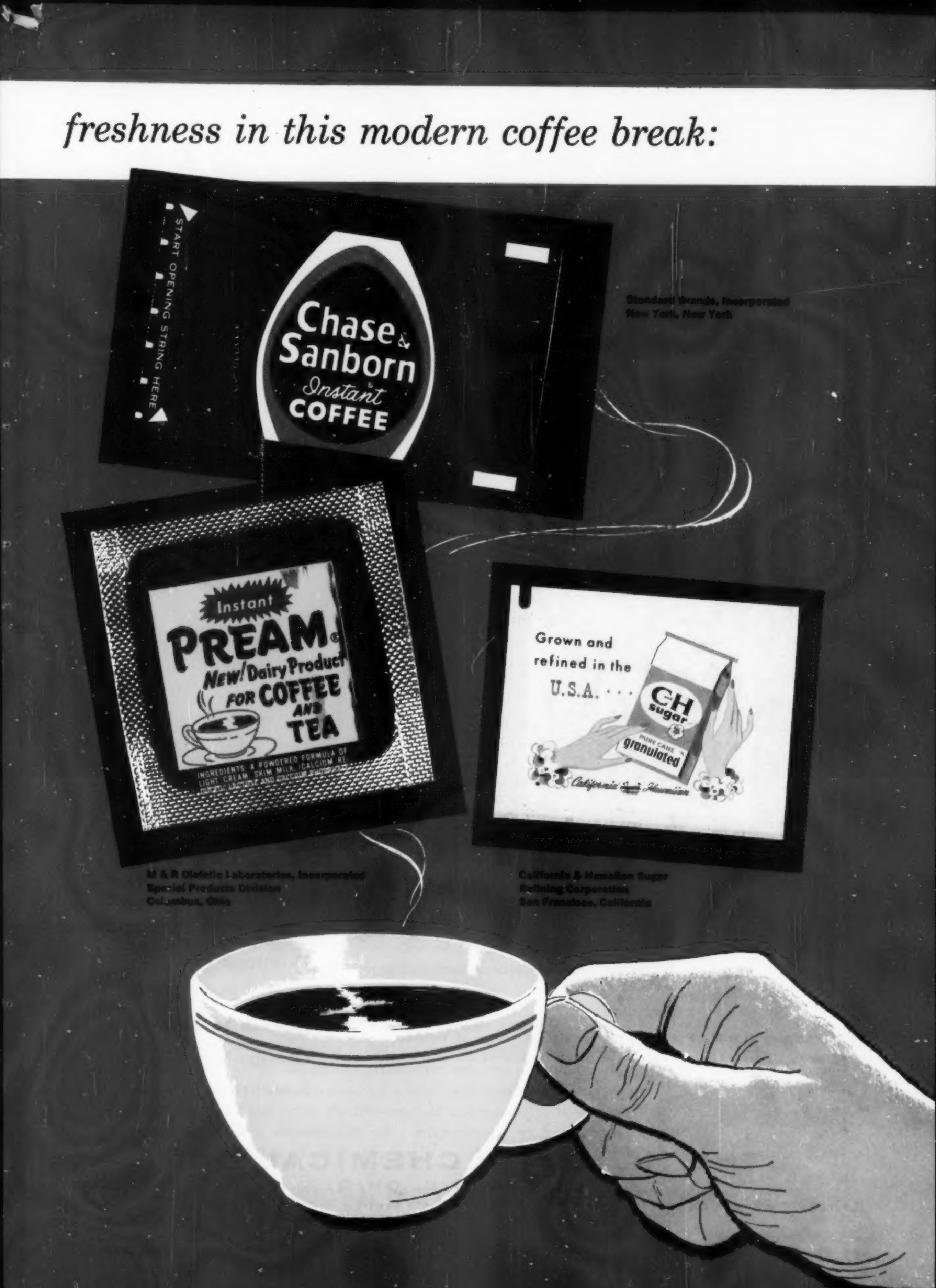
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for industrial finishes...plastics

exceptionally heat stable—excellent permanence—exceedingly easy to disperse

CADMIUM RED PIGMENTS

Cadmium Lithopones

Orange Red No. 70

Light Red No. 80

Medium Light Red No. 90

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BLEED PROOF

SAMPLES AND COLOR FOLDER showing full range of Yellows and Reds, CP and Lithopone, will be gladly furnished on request

THE HARSHAW CHEMICAL CO.

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HARSHAW


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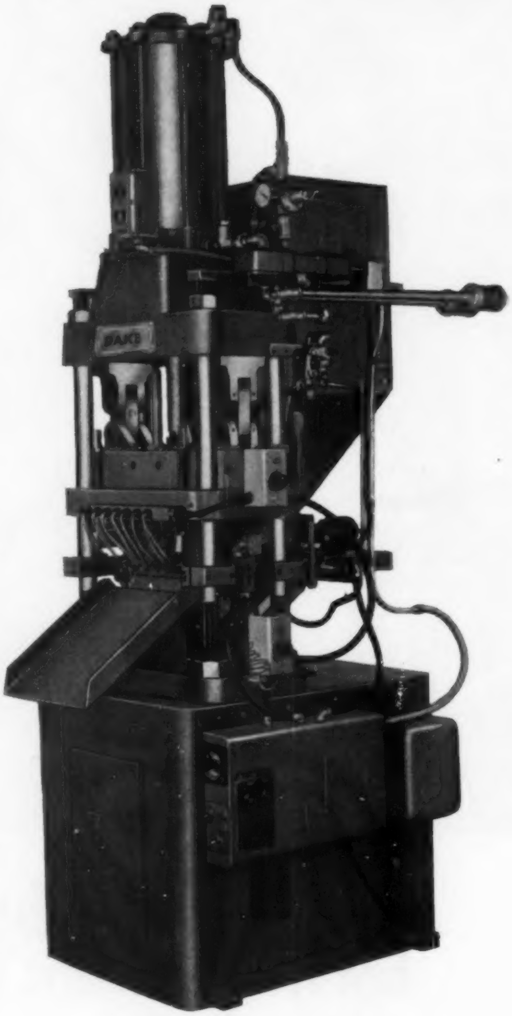
Announcing the new...

DAKE AUTOMOLD

LOWEST-PRICED HIGH-SPEED AUTOMATIC MOLDING PRESSES



Dake Automold presses are engineered for fast, dependable, economical molding of phenolic, urea, alkyd and epoxy compounds. You get more production with less maintenance *at lower cost!*

Take production, for example. Several users operate Dake Automold presses on a fully automatic basis . . . 24 hours a day, 7 days a week. There are no rest periods, coffee breaks, washups or lunch times, so Dake Automold presses deliver up to 14% more work than semi-automatics. Dake Automold presses are not only the most reliable, they also have the fastest dry cycle speeds. Opening, unloading, filling and closing to the "slow close" point all take place in less than four seconds.

Maintenance costs are reduced, too, because of the simplified, air-operated toggle design. The feed tray is actuated by positive cams through the same mechanism, eliminating the need for additional feed cylinders and control valves.

And look at the savings. Your initial investment is lower than for other automatic presses of equal capacity. More important, one man can operate a battery of presses because the Dake Automold press requires only a fraction of a man's time to load the hopper and remove molded parts.

Dake Corporation recently acquired all rights to the Automold press line from the Automold Company—hence the name DAKE AUTOMOLD. In the future, Dake's nationwide sales organization will serve you on these superior automatic molding presses, plus the complete line of other Dake plastics presses.

Model 49-050
(50-tons capacity)

Write today for a free copy of Dake's compression molding "Data Book". It discusses the economics of automatic thermoset molding, gives case histories, and explains many features and advantages of the Dake Automold line.

DAKE CORPORATION
648 Robbins Road, Grand Haven, Michigan

DAKE PRESSES


Arbor Presses


Hand-Operated Hydraulic


Power-Operated Hydraulic


Guided Platen


Gap Type Presses


Movable Frame

U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

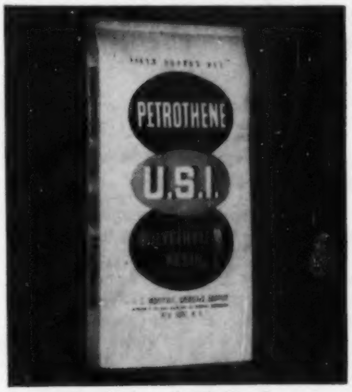
Packaging Notes

On-the-spot polyethylene skin packaging is revolutionizing the moving industry. With a new portable machine which can be rolled right into a home and run on any 110-120 volt circuit,

barrel packing can now be accomplished in 25% less time at a 33% savings in material costs. Device applies a tight, 6-mil polyethylene film cover over small or fragile articles, anchoring them firmly to a polyethylene-covered corrugated board. Full cycle is said to take less than 30 seconds. Standard moving barrels are used.

Because of its easy portability, this machine is also being utilized by manufacturers for in-plant packaging of electrical components, spare parts, etc.

New Bag For U.S.I. PETROTHENE® Resins



A newly-designed 50-lb. bag now packages U.S.I. premium PETROTHENE resins. It has an outer ply of semi-bleached Kraft, imprinted with a new 3-oval U.S.I. insignia. Look for this bright white, red and black bag, instead of the familiar red on brown one, next time you order.

Blow Molding Upturn Ushers In New Products

May Yet Rank With Injection Molding As Polyethylene Market

Blow molding, a 50-million-pound polyethylene market in 1960, is expected to show dynamic growth in 1961. Predicts Vincent D. McCarthy, Director of Plastic Sales for the U.S. Industrial Chemicals Co.: "This year blow molding will climb faster than ever . . . and may eventually compare with injection molding as a market for polyethylene." Injection molding now consumes 250 million pounds of conventional polyethylene yearly.

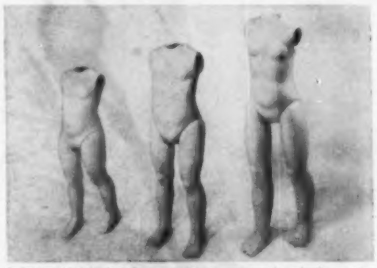
"The tremendous growth of blow molding high density polyethylene has also created a substantial demand for blow molding conventional polyethylene," he explains. "The use of conventional resins, either by themselves or in blends with high density resins, will continue to increase."

Technical advances are also contributing to blow molding's upward trend—spurring new products, creating new applications.

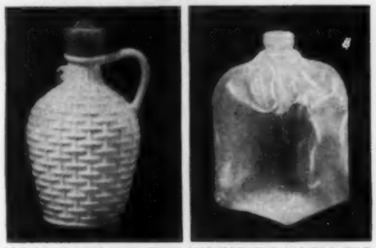
A Long Island, N. Y., plastics company, for example, is now making a walking doll 40 inches tall. New techniques, the recent acquisition of extremely large blow-molding equipment, and the consistent uniformity of the U.S.I. resin used are credited with making production possible.

And, from Europe comes report of the popularity of a polyethylene wine flask. Blow-molded in Portugal from a PETROTHENE resin, it's said to be ideal for short-time storage. A simple treatment overcomes any influence of polyethylene on flavor: Filling the container with pure water, leaving it for 24 hours, then emptying apparently does it.

In this country, news is being made by a 5-gallon *collapsible* jug—extrusion blow-molded from PETROTHENE by a Cleveland concern. This corrosion-resistant container can transport and store virtually any liquid, costs only about 90¢ with cardboard carton.



DOLL BODIES blow-molded of polyethylene to proportions of 2-, 3-, and 4-year olds. The biggest doll is 40 inches tall.



WINE FLASK and COLLAPSIBLE 5-GALLON JUG are typical of new products being blow-molded of U.S.I.'s PETROTHENE polyethylene resins.

Hot-Transfer Process to Decorate 300,000,000 Bottles

The tide of blow-molded bottles decorated by the relatively new hot-transfer method is rising steadily. According to the company developing the process, it will be applied to more than 300 million plastic bottles during 1961.

Success of the technique is attributed to both its efficiency, and the recent breakthrough of low-cost, semi-rigid polyethylene bottles.

Reportedly, equipment is now available for applying multicolor designs to bottles of any shape "at speeds up to 100 units a minute at a fraction of the cost by other methods."

Automatic machine applies wrap-around labels to cone-shaped bottles. Design is reverse-printed on heat-release coating. Post-heating ovens impart gloss to the transferred printing.

Pipe, Fittings of Polyethylene OK'd by New York City

For the first time, the N.Y.C. Board of Standards and Appeals has approved polyethylene pipe and fittings for acid and chemical waste systems. The approved drainlines, made by a Rochester, N. Y., company, are now also acceptable to Buffalo, Cincinnati, Detroit, Los Angeles, the State Plumbing Code of Michigan and the Plumbers' Examining Board of Richmond, Va.

POLYETHYLENE PROCESSING TIPS

Series VI, No. 2

HOW TO PREVENT RESIN CONTAMINATION IN YOUR PLANT

Contamination in polyethylene resins can mean increased down-time and lower product quality. Both are costly results which can be prevented by a few simple precautions in handling and processing resin.

The producer, of course, has the responsibility to make sure that resin arrives at your plant in virtually contamination-free condition. U.S.I., for example, carries out strict quality control sampling of every PETROTHENE® polyethylene lot produced at its Tuscola, Ill., and Houston, Tex., plants. Engineers also maintain a constant check on production and handling facilities to detect possible sources of contamination before they can cause trouble.

Once the resin arrives at the customer's plant, it is his responsibility to prevent contamination during handling and processing steps. This is relatively simple if he follows the basic procedures outlined below.

Check the Container

There need be no question about the purity of PETROTHENE resin arriving at the processor's plant if the container is *sealed*. While all due care is taken in packaging and loading resins, some container breakage may occur.

Resin in containers arriving either broken or opened should not be used unless it is definitely established that no contamination has occurred. Instances of opened or broken containers should be reported immediately to the nearest U.S.I. sales office. This can help U.S.I. in determining where the breakage occurred and preventing its happening again.

In-Plant Conveying

Polyethylene resins are transported from their point of arrival in a processor's plant to the processing machine in a variety of ways. Which method is used depends on the type of container the resin is in and the size and type of processing operation involved.

In large operations, where Dry-Flo* carlots of resin are used, conveying systems are usually installed to move the resin either directly from the car to the processing machine, or from the car to storage silos, and eventually, to the processing machine. Where this is the case, the conveying system should be inspected regularly for loose fitting sections or other possible contamination entry points.

Hopper loaders of one type or another must be used with Sealdbin† shipments of polyethylene resin. These loaders should be designed to eliminate resin hang-up and checked regularly for possible points where contaminants can enter.

An important rule to remember is that any resin loading system should be closed. Resin containers or equipment hoppers which remain uncovered for long periods of time are a major cause of resin contamination.

Opening Bags

Most U.S.I. PETROTHENE polyethylene resin is shipped in 50-lb. multiwall paper bags. The inner ply has a coating of polyethylene to protect the resin from contamination by paper fibers, moisture and other foreign matter. Unfortunately, unless the bag is opened with care, bits of foreign matter may get mixed in with the resin.

First step before opening a bag is to brush the top section of the bag clean of any loose dirt and dust. Usually there is some, as this is unavoidable in shipping and storage.

Do not use a knife to open a bag. This will lead to contamination by paper fibers. The proper way is to open the bag by pulling apart the strings used to close its top after filling. The simple procedure for opening the bag is described in the data sheet, "How to Open a Polyethylene Resin Bag", which can be obtained from U.S.I. on request.

Opening Cardboard Containers

Cardboard containers of PETROTHENE resin are sealed with metal bands. In opening these containers, too, it is important to first wipe the top to remove dirt and dust which may have accumulated. As in the case with 50-lb. bags, cardboard boxes should never be opened with a knife. The proper method is to cut the metal bands and remove the container lid. The polyethylene liner found inside all U.S.I. cardboard containers should then be unfolded and placed over the top edge of the box before discharge of the resin. This liner helps further to protect the resin from contamination between charges to the processing machine hopper. The liner should be used to recover the unused resin before replacing the container lid.

Good Housekeeping

Even when all the above precautions are taken, some resin contamination may result from poor shop housekeeping. Processing areas should be kept clean so that dust and dirt, which can contaminate the resin during the brief intervals when it is uncovered, are kept to a minimum. A dirty processing area will always cause some degree of resin contamination, regardless of other steps taken to prevent it.

The last place where resin contamination can occur is in the processing machinery itself. Since this "Processing Tip" is primarily concerned with eliminating foreign material in the resin cubes and pellets, listing good processing practices in detail is beyond its scope. It is important to remember, however, that regular maintenance and cleaning of processing machinery not only will prevent resin contamination but also will insure optimum machinery and resin performance.

*Registered trademark of General American Transportation Corporation.
†Registered trademark of United States Rubber Co.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
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IMPLEX in a man's world

IMPLEX, the high impact acrylic, goes where the tough jobs are . . . where great strength and rigidity, plus resistance to staining, are important selling points for a product. The fishing reel cover, transistor radio case and water-powered knife sharpener housing shown above* have rugged durability because they are molded of IMPLEX. This Rohm & Haas molding material also provides an attractive appearance by imparting high surface gloss and rich colors. Our design staff and technical representatives will be pleased to help you use IMPLEX for your present and prospective products—to your advantage. Just write and tell us about a specific project.

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IMPLEX

MODERN PLASTICS

March 1961 Volume 38, Number 7

The year of innovation

There will be held this year two major plastics expositions—in New York City and in London—and others in Ghent, Belgium and Toronto, Canada.

It is two and a half years since the last American plastics show; two years since the last British show. Much of import has happened in the interim.

In the past two years, the international marketing picture has changed greatly, with cross-licensing for the production of materials and machinery, with the establishment of associated companies, joint ventures, and subsidiaries all over the world.

In the past two years, almost every material maker has broadened his range of resins, has added new copolymers and alloys.

In the past two years, markets for plastics in the automotive, building, home appliance, packaging, furniture, and other basic fields have broadened greatly.

In the past two years, blow molding has become big business, foams have forged ahead, automation has been intensified, screw preplastication has taken hold, plastics have replaced in many cases stamped and die-cast metals.

In the past two years, plastics have come to compete more and more with other plastics, and selection of a plastic for a given application or for use with a given process has become more complicated.

And what of the next two years? The plastics expositions are where to find out. MODERN PLASTICS has been surveying the exhibitors of all these shows and can report that there will be on view more new materials, more new equipment, and more new applications than ever before.

Our survey also indicates that these shows will be truly international both in exhibits and in attendance.

This is the year of innovation—on a world-wide scale!

Hiram McCann

Modern Plastics Executive and Editorial Offices: 575 Madison Avenue, New York 22, N.Y. Tel.: PLaza 9-2710; TWX: NY 1-3063; Cable address: BRESKINPUB. After March 17, write to: 770 Lexington Ave., New York 21, N. Y.

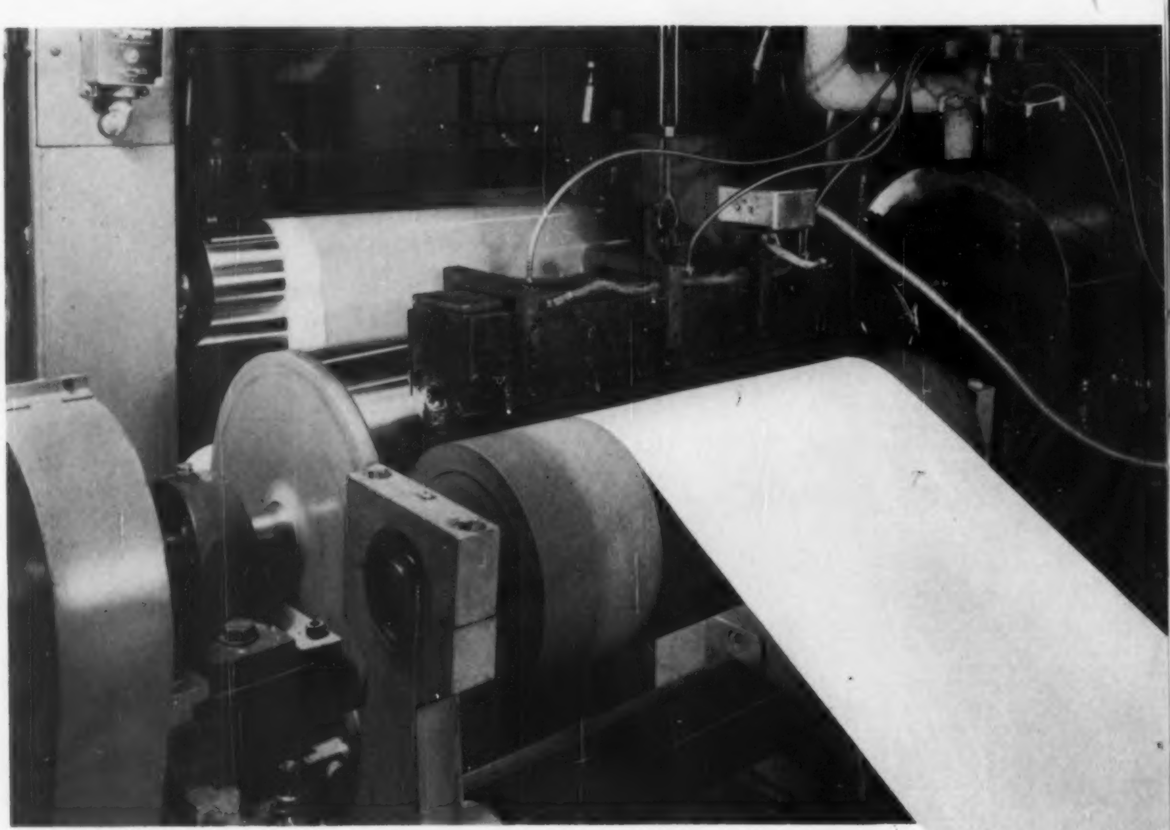


Photo. Union Carbide

Better products through

The wide range of types available and their varied range of properties have won for PE coatings new markets far beyond established packaging applications

The growth in polyethylene extrusion coatings over the past several years has been impressive. From 1954 to 1960, consumption of polyethylene (PE) resins for extrusion coating rose from some 15 million lb. to approximately 55 million lb., and industry sources are projecting 1963 consumption in terms of 100 to 150 million lb., and a possible rise to 300 million lb. by 1965.

Sparking this rapid growth has been the increased application of coatings for packaging materials. Packaging is far and away the largest end-use area today; it should continue to be so into the foreseeable future. But PE extrusion coatings have now also moved into many non-packaging products: low-cost luggage; covers for textbooks, pamphlets and booklets; disposable baby diapers; equipment tarpaulins; paper cups and plates; agricultural mulch and nursery wrap; and moisture barriers for construction. But just what is a polyethylene coating? How is it applied? What resins are used and why? And what materials can be coated?

The process and the resins

The technique of extrusion coating consists essentially of extruding hot (about 600°F.) PE resin through a flat film die, and drawing the molten web down through the nip of two rolls and laminating it to a substrate. (For details on the process see "Take your choice of coating methods," MPI, Sept. 1958, p. 90 and Oct., p. 91.)

A PE coating performs one or more of three major service functions—it acts as a barrier (e.g. against moisture), provides a means of heat sealing, or serves as a laminating medium. In addition, it may be used to provide improvement of strength, of abrasion resistance, and of gloss of the coated material. Unfortunately, no one

resin will give maximum performance in terms of all the properties required and the best processing economics. And the problem for the specifier of coating resins is to find the compromise which will deliver the best *combination* of physical properties in the end-product—and in conjunction with the most economical processing characteristics. The following rules of thumb for resin selection—based on density, melt index, and molecular weight distribution of resins—indicate how these three variables affect properties.

Low-density (0.915 to 0.925) resins: these provide high coating speeds (325 to 1000 ft./min.), low coating weights (as little as 2 lb. of resin/ream where applicable), heat sealability at minimum temperatures (approximately 270° F.), and good anticurl characteristics.

Low-density resins, in fact, might be called the workhorses of the extrusion coating field, being used for coating a variety of substrates in a wide range of packaging applications.

Medium-density (0.926 to 0.940) resins: compared with the previous resin category these offer improved barrier properties and resistance to higher temperatures; at the same time, they are heat-sealable at *moderately* low temperatures.

High-density (0.941 to 0.965) resins: these are relatively new and, consequently, not yet widely used. In fact, only one supplier presently has such a resin for extrusion coating, although several others have indicated intentions of producing such products. The main attraction of high-density resins is their superior barrier properties. Coating speeds for high-density resins, only 250 to 380 ft./min., are much slower than more commonly used low-density and medium-density types. However, there are reports that much faster-speed resins (perhaps running better than 600 ft./min.) may be introduced soon. Minimum coating weight for high-density resin is 4 to 6 lb./ream, but this too may come down with faster-coating formulations.

Melt indices are a factor in resin selection mainly from the standpoint of coating operation

polyethylene coatings

Photo: U.S.I. Chemicals

ANNUAL REPORT cover is coated with PE to provide durability, resistance to moisture and soiling, and to add gloss. Coating takes 10 lb. of PE/ream of paper.

Photo: Union Carbide

KRAFT PAPER is coated with a 2-mil layer of PE and then bonded to chip board to make inexpensive luggage. Polyethylene coating imparts handsome look and feel plus abrasion resistance.

economics and performance, and a resin must have a reasonably high draw-down speed to permit an economical coating rate. As melt index is increased, draw-down speed goes up. Neck-in, in which the edges of the molten film tend to draw inward due, in part, to the elasticity of the hot polymer, is also a function of melt index and density. Generally, the lower the melt index and density, the less neck-in, with subsequent reduction of trim and waste. The problem of neck-in can also be decreased by reducing the die setting and stock temperature. Increasing take-off speed also tends to reduce neck-in.

Molecular weight distribution as a factor in selecting a resin demands consideration mainly in terms of its effect on coating speeds and thicknesses. Resins with broader molecular weight distribution generally have higher draw-down speeds; however, those with narrower molecular weight distribution (most coating resins are of this type) present less of a problem of neck-in, polymer smoking, and odor. It should also be kept in mind that the high temperatures used in extrusion tend to increase the flow of a resin. Thus the apparent lesser flow of a resin with narrow molecular weight distribution is not as critical as it may first appear.

In addition, greaseproofness is somewhat improved by using a resin with narrow molecular weight distribution. A coater often obtains better greaseproofness with a low-density, narrow molecular weight distribution polymer than with a medium-density, broad molecular weight distribution resin.

Actually, there is no way that the customer for an extrusion-coating resin can measure this factor, so it is best to check with the resin supplier to see how molecular weight distribution, as it interacts with density and melt index of that supplier's resin, will affect the properties desired in the coated material.

Which substrates to use?

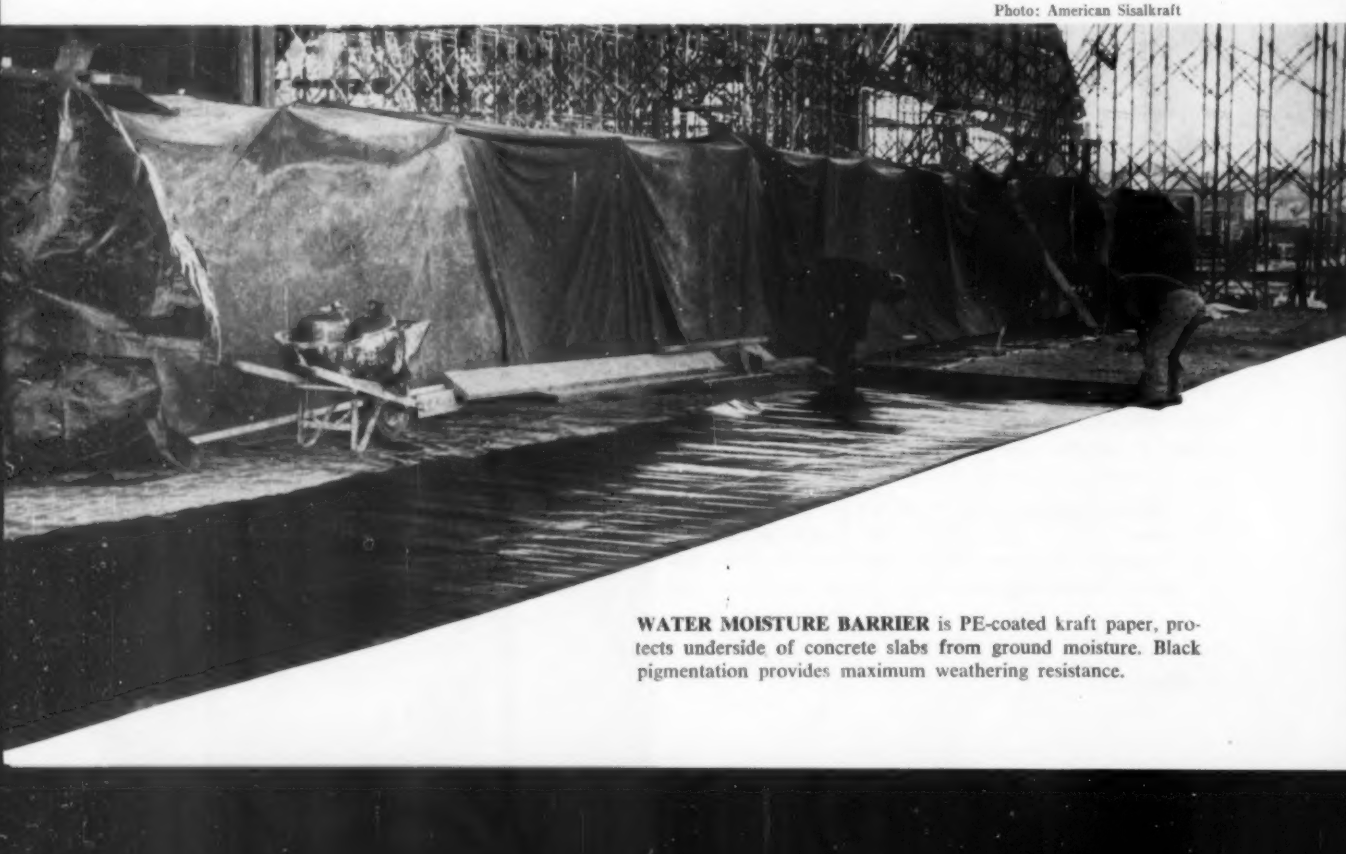
Some materials just cannot be—or, at least, haven't been—successfully coated. But others—"substrates" to extrusion coaters—have gained wide application where proper selection of coating resins has been made.

Paper and paperboard account for the largest volume of all PE-coated products. It is estimated that paper accounts for about 60% and board about 10 to 15% of PE coating resins. The remaining 25 to 30% is distributed among such specialty substrates as cellophane, foil, polyester film, scrim cloth, and burlap.

Cellophane-PE combinations are primarily used in the food packaging field. The PE coating improves cellophane's durability and adds heat sealability, while the cellophane contributes gas resistance and high clarity.

Aluminum foil is coated with PE primarily to permit heat sealing, fill pinholes, and improve puncture resistance and low-temperature flexibility. Coating on foil is usually done at lower speeds

Photo: American Sisalkraft



WATER MOISTURE BARRIER is PE-coated kraft paper, protects underside of concrete slabs from ground moisture. Black pigmentation provides maximum weathering resistance.

than paper coating, in order to minimize waste from necking-in. Coating thickness on foil ranges from ⅔ to 2 mils of PE; low-density resins are most often used.

Heat sealability and heat resistance are prime reasons for coating polyester film with PE resin. These combinations are used in packaging for "heat-in-the-bag" pouches. The PE/polyester film combination offers excellent strength, dimensional stability, and high temperature resistance. Medium-density resins are most often used.

For coating such substrates as rayon, cotton, scrim, and burlap, the use of PE is small in volume at the present time.

Selection of a substrate is equally as important as selection of a coating resin. Variations in substrates from different suppliers may be found in fiber formation, method of manufacture, and degree of finishing. These factors can affect adhesion, pinholing tendencies, and heat-seal strength of the polyethylene coating. It is important, therefore, that the end-user request specific information on the desired substrate from the supplier, or provide him with precise specifications for the material.

Photo: Continental Can

POLYESTER FILM coated with PE forms pouch for single serving of sirup. Film combination provides clarity, low gas permeability, and hermetic heat seal.

What are the applications?

The largest market for PE extrusion coatings, as mentioned, is packaging. The first commercial application was in multiwall bags, which were pioneered by Du Pont and St. Regis Paper Co. to replace asphalt plies as a barrier against moisture in the bags. The coating did a better job in protecting moisture-critical contents from caking, and also eliminated the problem of cracks in the barrier wall due to extensive handling.

Polyethylene-coated multiwall bags today are used widely by the chemical industry to package such products as calcium chloride, ammonium nitrate, polystyrene, acrylonitrile, nylon, and methyl methacrylate.

As a coating on kraft paper, PE complements the reinforcement and ready printability of the substrate by adding moisture impermeability, heat sealability, and good contents-release characteristics. Low-density resins, widely used for coating multiwall bags, have only one-quarter the moisture vapor transmission rate, pound for pound, of asphalt coatings. Since high-density resins will give an even better performance in protecting against moisture, they are expected to become top contenders for the multiwall bag market, once they become available in greater quantity and lower price to coaters.

All told, PE resins for coating multiwall bag stock accounted for an estimated 16 to 20 million lb. in 1960. Coating weights on kraft generally range from 6 to 20 lb./ream.

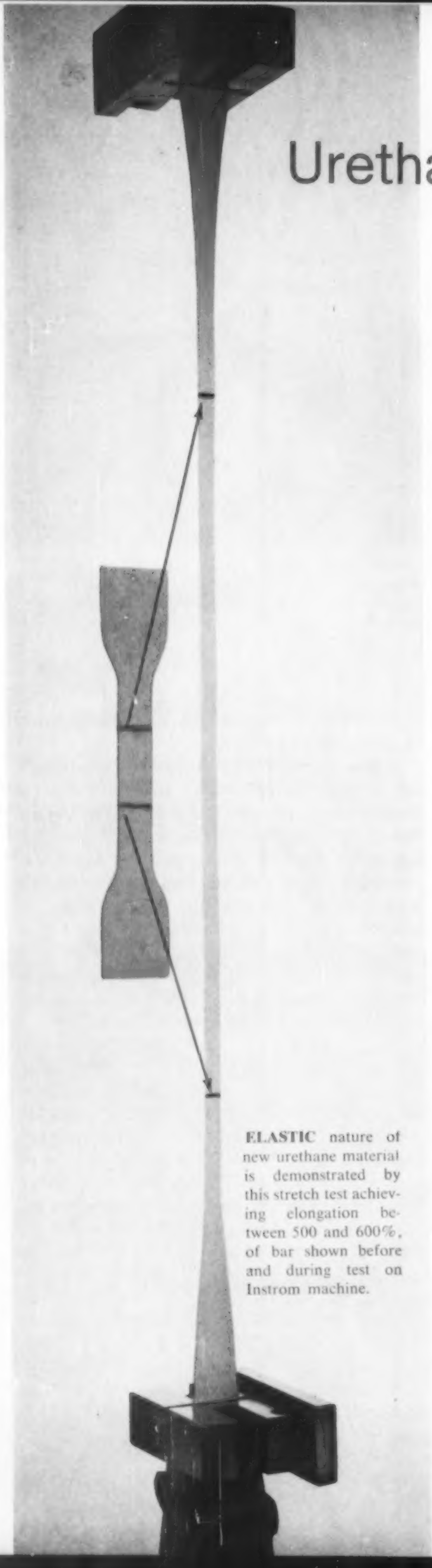
In the coating of bag stock, one manufacturer has developed a process by which a vacuum is drawn through the substrate prior to the application of the polyethylene. Essentially, this process causes the fibers in the substrate to flatten out, permitting use of a thinner and more economical coating while avoiding the consternations of wicking or pinholing problems.

Pouch packages, which account for an estimated 12 million lb. of PE resins today, encompass a wide range of substrates—paper, cellophane, aluminum foil, and polyester film. A leading example is the coated paper sugar pouch, which consumes about 1 million lb. of PE today. This market is pretty much saturated, but there are other areas of great potential, including pouches for bakery pre-mixes, dessert toppings, powdered soups, and dehydrated vegetables in the food field and small metal housewares items and powdered detergents among non-foods.

Polyethylene coatings for pouches serve primarily as a barrier and heat-sealing material. But they also find use as a laminating medium. An example of the latter is a paper/PE/foil/PE pouch, in which the first PE web is the bonding medium between paper and foil, and the second web performs barrier and/or heat-sealing functions.

About 5 million lb. of PE are consumed in the coating of foil at the present **(To page 158)**

Urethane elastomers:



ELASTIC nature of new urethane material is demonstrated by this stretch test achieving elongation between 500 and 600%, of bar shown before and during test on Instrom machine.

Photo: Mobay Chem. Co.

Whether you are a processor or an end-user of plastics, the recent introduction of elastomeric urethanes that are processable on equipment designed for plastics injection, extrusion, and transfer molding has far-reaching implications.

As a processor, it means that you can now enter markets that by virtue of the older cast urethane technology had been essentially closed to you—and do so without any capital investment.

As the end-user, it also means that you may save as much as 50% of the cost of the finished item, as compared to a cast piece, while retaining all of urethane's desirable end-product properties.

Of course, urethane elastomers have been on the market for several years (see "The urethanes grow up," MPl, June 1959, p. 101), and industrial designers have been aware for some time of the outstanding properties of the materials. But manufacturers have been equally aware of the slow and costly techniques by which these urethanes had to be processed . . . as a result, the urethane elastomers really never have gotten off the ground. And while many applications have been developed, their total represents only a small fraction of the over-all potential.

This situation is now changed. Urethane elastomers can now be processed at rates comparable to those of other plastics.

Two distinct types available

These new elastomers, however, are not all of the same family. Basically, they fall into two distinct groups. One type is thermoplastic, the other is thermoset. And while both are processable on plastics extrusion, injection-molding, and transfer-molding equipment, there are significant differences both in properties and operating conditions. The two types of elastomers also differ somewhat in basic marketing goals.

What are the economics?

Under the old casting system for producing urethane products, four steps are involved: 1) Prepare the prepolymer; 2) mix with curing agent under closely controlled temperature conditions; 3) pour into mold—where it has to remain for from 20 to 30 min.; 4) strip from mold and postcure. Where close dimensional specs were involved, the cured molding had to be machined to exact size.

With the new materials standard plastics proc-

new material for plastics processors

Refined formulations, processable on plastics molding equipment, pave the way for penetration of markets formerly pre-empted by rubber industry

essing techniques are used. The urethane is furnished in pellet form and, for example, injection molded on standard equipment, using standard pressures, temperatures, molds, and runner systems. Cycles of 30 sec. for a typical 2-oz. shot are reported. In the case of the thermoplastic urethanes, the product will have its full properties as molded; in the case of the thermoset urethanes, a postcure is required to bring in the full properties. The two types also differ in recycling of scrap: thermoplastic urethane scrap can be recycled indefinitely; with the thermoset type, while recycling is possible, the number of recycles may be limited and machine temperature may have to be raised with each pass.

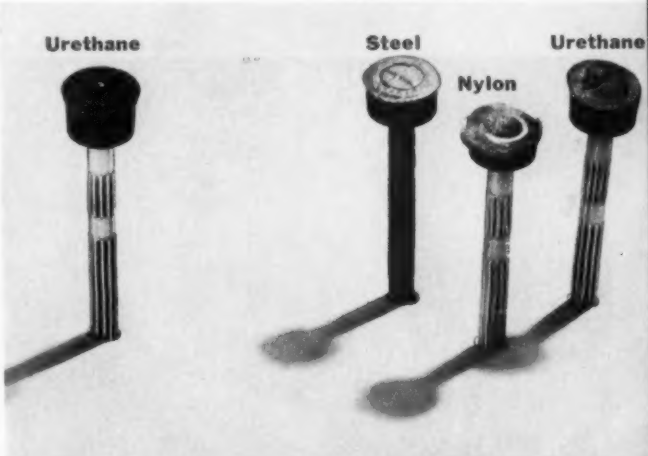
What do the new materials mean in terms of economics? A finished article produced by urethane casting (or by compression molding of cast sheet) ranges in cost from \$3 to \$5 per pound, based on a raw material cost of \$1 per pound. By injection molding the same parts of the new elastomers, end-product cost is reduced by 30 to 50 percent.

What are the markets?

Since the two materials differ in several respects, their market aims do not exactly coincide, although they overlap in some respects.

One of the overlapping markets is cable jacketing. In this application, the material is used as an extrusion. The total potential for this application is around 700 million lb. a year; however, urethane elastomers, being higher-priced than several other jacketing materials, can expect to capture only a small fraction of this market. Specifically, the new materials would go into those applications where service requirements make the lower-priced materials inadequate. But even at a 5% penetration, annual consumption would run to 35 million pounds. And evaluation tests are now under way to determine whether a relatively thin urethane jacket can duplicate the properties of a heavy rubber sheath. If these **(To page 166)**

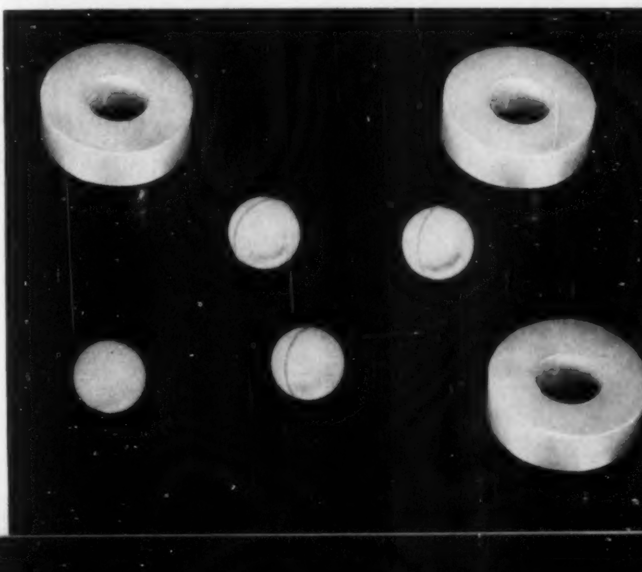
Photo: Whitso, Inc.



HEEL LIFTS are potentially large market for new urethane elastomers. Urethane lifts were molded of new thermoset material on standard plastics machinery. Lift at left is unused; in wear test lift at right outwore nylon, did not develop hosiery-snagging edges of steel lift and provided best traction on slippery surfaces.

HARDNESS as well as elasticity is a property of new urethane materials. These properties, plus resistance to shock, solvents, and aging, brought about selection of this material for injection-molded motor mounts and ball hinges used in Maytag automatic washer.

Photo: Mobay Chem. Co.



THE COVER: Close-up study of an injection-molded methacrylate lens placed against a reflecting surface. The lens, for use in photographic viewers, is one of eight molded in one shot at American Optical Co., as shown in the photograph below. Note molded-in flange.

LEARN FROM

Photos, American Optical

Injection molding lenses

LENSES are produced of optical-grade methacrylate in multi-cavity molds, need no finishing except for removal of sprues (below). Scrap is not reused for lenses.

Plastics' claims as a design material—better properties and/or lower cost—have rarely been more fully realized than in the field of optical goods. Here, in an industry that for ages had been completely dominated by a single material—glass—plastics have achieved new heights in quality, safety, processing ease . . . and frequently at phenomenal savings.

Where costs are lowest

Take for instance the area of large lenses. In the case of one producer, Fostoria Corp., Huntingdon Valley, Pa., these range from 4 to 30 in. in diameter and up to 4 in. in thickness. They are made of methacrylate and find application in projectors, magnifiers, collimators, reflectors, light dispersers, light concentrators, and similar devices . . . and at prices much lower than glass lenses of equivalent quality. The table that follows gives a good indication of the price spread between plastics and glass lenses. The figures are based on quotes for actual jobs. However, they are typical and will generally hold true for lenses of the sizes shown.

Size (diam.)	*Methacrylate*	*Glass*
in.	*$*	*$*
4	4.75	6
8	15	100
18	400	1200
24	800	8000
8 x 5 x 3 (Prism)	40	80

Why this startling price differential between plastics and glass? Two basic reasons: raw material costs and processing expenses.

Raw material: The large plastic lenses are produced from cast polymethyl methacrylate sheet supplied by the raw material producer. Cost will vary according to thickness and size, but in any case will be competitive with glass sheet.

To produce glass sheet 4 in. thick with the nec-

LENSES

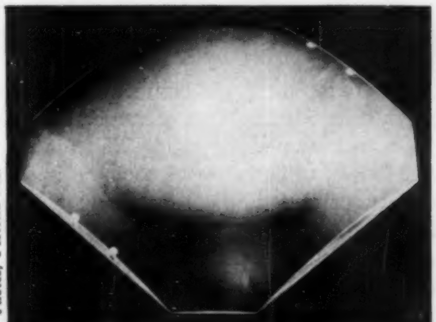
- How to gear processing to optical needs
- Why plastics can compete economically with glass
- Where transparent plastics provide superior performance

essary optical properties is a most complicated and lengthy process. In such thick sections, glass has a tendency to form striation, retain air bubbles, and lose some of its crystal clarity. To make it suitable for later processing, glass has to be annealed at slowly decreasing temperatures (sometimes for days). Thus, production is necessarily slow—and costly.

Not so with methacrylate sheet. Production of optical-grade sheet, while critical and requiring great know-how, is far less time-consuming.

Processing. In these large sizes, glass—considerably harder yet more brittle than plastic—adds a great deal of time to the production cycle. Even where plastics lenses are produced by optical grinding techniques long used with glass, the finishing process and the tools are far less costly.

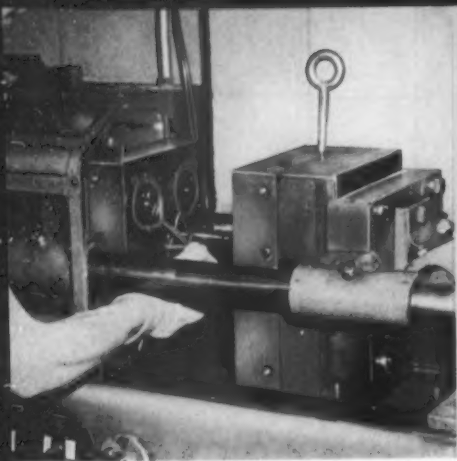
At Fostoria, for example, production of a plastic lens begins with a blank cut from sheet. This blank is next shaped on a lathe-type machine to a previously determined optical curve. With glass, this shaping has to be done with diamond dust tools at very slow speeds to prevent cracking. With methacrylate, less expensive tools are needed



Photos, Fostoria Inc.

Grinding lenses from sheet

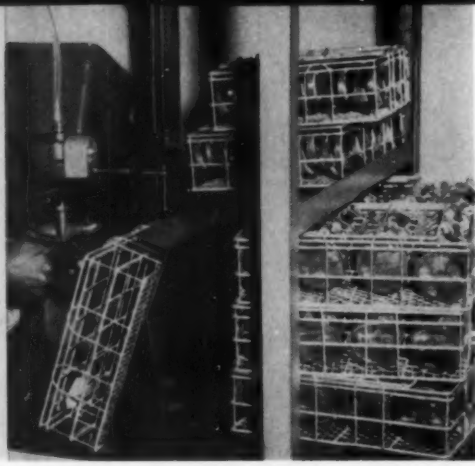
GIANT 30-IN. LENS at left has been worked on lathe-type machine to its optical curvature but is not yet polished. Above is another viewer lens (plano-convex), fully polished. Note mounting holes drilled in side, which is very difficult with glass.



Casting lenses

GASKET is injection molded of vinyl (left) for placement between halves of casting mold. Gasket acts as seal, helps determine thickness of allyl spectacle lens. Filled molds, placed in baskets (right), are oven-cured.

Photos, Applied Plastics



and faster cutting rates are possible. After the optical curve has been imparted to the lens—whether glass or plastics—the semi-finished product undergoes several polishing steps, including lapping, wet "sanding," felt polishing, etc. Again in each polishing step lower cost polishing media and faster rates are possible.

The economics are clear.

But what about quality?

If the price advantages are impressive, the improved quality and performance brought by methacrylate lenses is equally astonishing. These outstanding features include:

- Methacrylate lenses weigh only about half as much as glass. The advantage of this lighter weight in large lenses (and 36-in. units are on the way) needs no elaboration.
- They transmit more light than glass. Depending on the glass involved, the actual improvement ranges from 7 to 11 percent.
- They are impervious to thermal shock, which would frequently crack glass.
- They are effectively chip- and breakproof. The significance of this lies in the fact that the plastic lenses can be easily drilled and tapped to provide mounting holes as well as other means of attachment.

Of course there are limitations in the use of methacrylate lenses. One is temperature: 200° F. is about the upper operating limit for methacrylate lenses, while lenses of common optical glass can be employed where operating temperatures range up to 700° F. Another limitation of methacrylate is in its scratch resistance, which is below that of glass. While this characteristic brings important processing benefits, i.e., easier grinding and polishing, it also necessitates great care in handling.

Clearly, where large transparent objects are to be produced by the grinding of sheet, methacrylate is this most economical material. This applies not only to lenses but to: safety shields, massive windows, and other such applications requiring transparency and needed in limited quantities (the lenses produced at Fostoria are generally produced one at a time).

Ophthalmic advances of plastics

Unlike the large lenses just described, spectacle lenses present an entirely different set of requirements to plastics. As a result, new material and new processes come into play. At the same time, economics take on a different aspect. We are dealing here with prescription lenses, and matters of human safety outweigh considerations of expense.

Generally speaking, plastic spectacle lenses today cost the ultimate consumer about twice as much as do glass lenses, although the cost of making plastic lenses is only about 30% higher than that of making ordinary glass lenses, and about the same as for case-hardened glass.

Despite the many advantages offered by plastics in this field, the higher cost has held back their penetration of this market. Total annual production of all spectacle lenses in the United States is estimated at about 50 million. According to American Optical Co. (AO), Southbridge, Mass., plastics' share of this market ranges between 1 and 2 percent. Under present formulations and processing techniques, this figure may be expected to reach a top of 10%, in the view of AO, major supplier of both glass and plastic lenses. This growth can be expected through education of users. To achieve a penetration beyond that 10% level, radical changes in both materials and processing would be necessary.

Advantages. Why, in the face of this cost disadvantage, have plastics lenses been able to make even a 1 or 2 percent penetration? Here are some of the reasons.

- Unbreakability. For certain wearers, this property is paramount: children, active adults, sportsmen. While plastic lenses can be broken, they shatter into fragments that do not cut like glass and thus do not endanger the eye.
- Moldability. Aspherical lenses, generally

required by cataract patients, cannot be produced from glass, except by a most laborious grinding method. Plastic lenses can be cast in precision glass molds to the requisite curvature at reasonable speeds.

• Weight. For people requiring thick lenses, the fact that plastics weigh just about half as much as glass can mean a real difference in wearing comfort.

Because of these reasons, plastics have made their best showing in the spectacles field in the thicker and cataract-type lenses; in these smaller areas they account for far in excess of the 1 to 2 percent they represent in the over-all U. S. spectacles market.

How they are made: Spectacle lenses are generally produced from allyl and allyl copolymer resins. Because of the type and frequency of handling to which they are subjected, scratch resistance in such lenses is extremely important; and the abrasion resistance of allyl is about 30 times that of methacrylate.

Applied Plastics Corp. (APC), Roosevelt, N. Y., a subsidiary of Univis Inc. and a specialist in a wide range of plastic lens applications, uses the following procedure to make prescription lenses (other makers use essentially the same basic processes, although each company will have its own proprietary variations):

The first step is the preparation of a resin mix. A typical formulation would be:

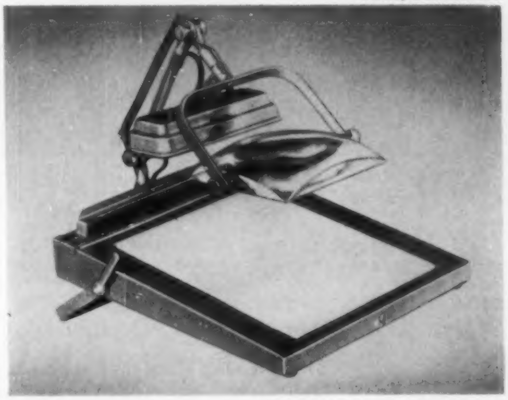
allyl diglycol carbonate	96½%
iso-propyl percarbonate	3½%

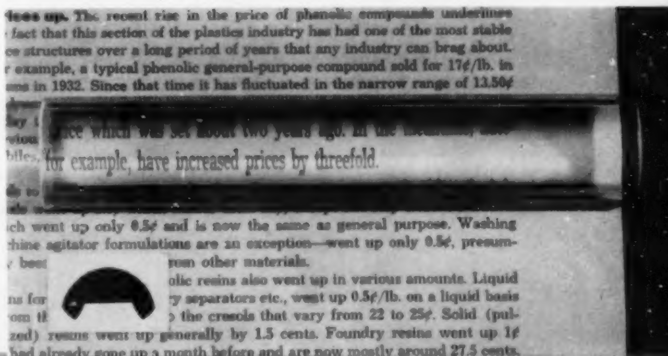
At APC, the resins are pumped from drums into 15- to 250-gal. mixing tanks, with proportions determined by weight to assure an accuracy within 0.25% in formulation. Catalysts are added to the mix, which is then agitated for 30 to 90 min. and filtered repeatedly.

The heart of the formulating process is proper filtration. Optical clarity demands that particles larger than 1 micron be entirely eliminated. APC has found that a most successful method is to use a 5-micron disposable filter cartridge built up with a ⅛-in. precoat layer of diatomaceous earth as a filter aid. The filter aid is mixed with the monomer and deposited on the surface of the filter cartridge, along with the larger particles of resin which it has picked up, by repeated recirculation of the formulation.

The actual production of spectacle lens consists of casting and curing catalyzed liquid resin in precision-ground and polished glass molds. Two-part molds are assembled in a dust-free room and the two halves spaced by an injection-molded vinyl gasket. The gasket acts as a seal for the mold and helps determine the thickness of the lens. The assembly is clamped with a spring clip adjusted to apply the (To page 181)

Photo, Fostoria Inc.





Photo, Anchor Plastics

Photo, Tool Components

Plastics lens applications

FROM TOP: photographic viewer using lens made from methacrylate sheet; plano-cylindrical lens cut from extruded profile (see sketch) magnifies in only one direction; magnifying lens of drafting scriber is cut from acrylic rod stock, then machined, ground, and polished, at one-third cost of glass.

Sandwiches to order

Panels incorporated into the cabin design of Convair's Jet 880 serve many ends—but the materials in each are chosen with a particular major role in mind

Problem: Design the interior of a jet passenger plane with materials that combine: 1) high strength-to-weight ratio; 2) efficient thermal insulation; 3) acoustical damping; and 4) pleasing appearance. Solution: Use plastic sandwiches.

This, briefly, is the story of the Convair 880 interior. But behind this "simple" solution lies a major revolution in design thinking: *All* the design requirements were met by using sandwich panels. Involved are hitherto unknown types of construction, with various combinations of cores; new face materials; novel decorative skins; and special adhesives to bond these components.

Basically, there were three areas of sandwich applications in the 880: hatrack flooring, partitions, and wainscoting. In each case, the choice of the specific sandwich structure was highly successful; and it is generally expected that this success will lead to broad use of similar panels in other transportation and construction areas.

All panels for the 880 are produced by Dumont Mfg. Co., San Rafael, Calif., a subsidiary of H. I. Thompson Fiber Glass Co., Los Angeles.

Hatrack flooring: lightweight rigidity

The 18 panels for the undersurface of the hatrack had to provide a flat surface at minimum weight, yet be more rigid than the wainscoting. This increased rigidity was obtained by specifying

TO MAKE non-load-bearing partition that divides passenger cabin, phenolic-impregnated honeycomb core is laid down on glass-reinforced skin. Core and skin are bonded with phenolic adhesive.

THREE TYPES OF PANELS used in cabin of Convair 880 are shown in this overall view. In rear is partition with tile-printed vinyl film over glass-reinforced skin; at top right is under surface of hat-rack with skin of epoxy-impregnated fibrous glass cloth; below window is part of wainscoting panel with its tough phenolic-impregnated fibrous glass skin.

a cellular cellulose acetate (CCA) core. In addition to offering a high degree of rigidity at relatively low weight, the CCA core also provides a continuous adhesive line over the entire surface of the panel. The result is a smoother panel face than could be obtained with cellular honeycomb construction, the alternative considered.

The panels, which are used over the entire length of the cabin, are 28 in. wide, 8 to 10 ft. long, and ¼ in. thick. Skins are produced from prepreg material of 181 fibrous glass cloth impregnated with epoxy resin.

The core material is obtained in blocks ¾ in. thick, 4 in. wide, and 6 ft. long. These blocks are cut to required dimensions by Dumont and are then positioned on one of the skins together with an edging strip of spruce. The wood is used to increase density of the areas where panels are to be attached. Core and spruce are bonded to the two skins with an epoxy adhesive at 250 to 300° F. Later, metal inserts are embedded in the sandwich with epoxy putty at attach points.

Partitions: portable rigidity

Panels for partitions and removable coat racks are so designed that they may be inserted at any of six pre-determined points in the cabin. Although they are the most rigid of the panels used on the Convair 880, they cannot be considered truly structural. They had to be lightweight but with enough rigidity to sustain whatever insignificant loads may exist; for example, to support the doors separating one compartment from the other. The panels have maximum dimensions of 4 by 7 ft. and are crescent-shaped so that their outside rim conforms to the fuselage. Skins consist of two layers of 181 glass cloth impregnated with phenolic resins. These prepregs are bonded to a ¾-in.-thick phenolic-impregnated core of paper honeycomb with a modified phenolic adhesive. This core is much cheaper than aluminum honeycomb, yet supplies equivalent strength.

Wainscoting: abrasion resistance plus

The flat wainscoting panels run the full length of the passenger cabin and reach from below the window to a cove just above the floor. They comprise the area which takes the most abuse from cases, handbags, and other passenger belongings. Thus, the panels, in a single construction, had to be flexible, lightweight, and abrasion resistant, in addition to acting as sonic and thermal barriers.

There are 18 panels per plane, each 14 in. wide, 6 to 10 ft. long, and ¼ in. thick. The inner skin of the panels is made up of two plies and the outer skin of one ply of 128 glass cloth, both im-

WAINSCOTING PANEL is flexible, has tough phenolic-impregnated skin and vinyl foam core to shrug off kicks and scuffs. Metal clips bonded to the panel with a phenolic-epoxy formulation to permit easy installation.

HATRACK PANEL owes its rigidity and smooth surface to use of cellular cellulose acetate core which presented smooth unbroken adhesion surface for skin. Panels were precut to accommodate ventilating and light ports.

RIGID VINYL SHEET is bonded to upper part of partition. Water-soluble adhesive solved stain problem.

pregnated with phenolic resin to produce a precured (B-stage) fabric. Flexible vinyl foam, cut to the shape of the panel, is used as a core. Choice of the vinyl foam was based on its good flexibility and impact resistance.

After the inner surfaces of the skins are coated with a rubber-based adhesive, the core is placed between them, and the sandwich is cured at room temperature and vacuum pressure. Strength of the panel is considerable, since it can be deflected up to ⅛ in. across its width without damage.

Following cure, metal inserts are embedded into the rear edges of the panel with a putty made up of phenolic Microballoons in an epoxy resin formulation; inserts are spaced from 4 to 6 in. apart. Into these inserts are screwed special clips which permit the panels to be easily installed.

How to make them decorative

One of the significant aspects of the Convair 880 panel program was the use of decorative vinyl film bonded to the exterior sandwich face skins. A thin flexible PVC film was used on the wainscoting panels.

Because the thin flexible vinyl was light in color, initial adhesives had a tendency to bleed through and discolor. There was also the possibility of adhesive-fading two or three years after installation. Then, too, the use of solvent-based adhesives to bond two impermeable membranes together caused blistering. During test installations, some solvents would be trapped in the glue line and just a bit of exposure to sunlight or surface breathing would blister.

The final solution was found in a water soluble adhesive formulation. It was the only type that would eliminate the problems of blistering, discoloration, solvent-staining, and bleed-through.

Acoustical damping is achieved by perforating the vinyl sheet with 1/16 in. holes on 4-in. centers. These holes blend in with the overall design.

In jet design, weight is one of the most bothersome problems. The big advantage offered by these sandwich structures was that they met the design requirements at weight savings over other types of construction. In some instances these savings amount to more than 50% over composite structures (laminates) of equivalent performance value. It is this combination of performance and very light weight that suggests wide acceptance of these new sandwich ideas.—**End**

ANTENNA TRUNKS FOR $400 LESS

Switch to reinforced plastics in design of ship antenna housings also achieves 500-lb. weight saving

Photo, Texaco Experiment Inc.

Reinforced plastics antenna trunks for shipboard radio stations are providing cost savings of up to $420 per installation and weight savings of approximately 500 lb. over conventional steel units. Already they have been installed on more than 50 vessels.

An antenna trunk of welded steel—standard equipment until now—weighs about 700 lb. and ranges in cost from $1,000 to $1,200. In contrast, the current price tag on a 200-lb. RP trunk is only $780—and further savings are anticipated, since production costs for the RP unit are reportedly being lowered as techniques are improved. Along with the cost and weight economies, glass-polyester construction also provides performance advantages.

Keeps transmitter power up

Two perennial problems encountered with steel antenna trunks are the sapping of transmitter power by normal capacity losses of radio frequency current, and further loss, perhaps even disruption of service, due to accumulation of moisture inside the trunk. These problems are virtually eliminated in the RP trunks, because: 1) the electrical capacity loss characteristics of the RP material are extremely low; and 2) each RP trunk is designed for automatic drainage. The self-draining feature is made possible, and economical, through use of the trunk's base plug to form an elevated interior platform for insulator mounting. Weep holes are then drilled into the trunk around the plug to drain out moisture.

Produced by mandrel winding

The bodies for the trunks (which are 7 ft. 4 in. high by 25 in. wide) are made by wrapping polyester resin-impregnated glass roving around an elliptical mandrel, which is first coated with a hard wax parting compound and sprayed with a clear gel coat. Ten layers of 25-oz., resin-loaded woven roving are employed to build up a ⅜-in. wall. The surface is finished with two layers of 10-oz. roving, followed by a spraying of gray gel coat. After the single-piece trunk bodies have gone through a room-temperature cure, they are pulled from the mandrel for finishing operations. The weep holes are machined into the trunk near the base, and holes are cut into the side to facilitate addition of the trunk's platform and cap as well as future electrical installations. To form the platform, 12 plies of pre-loaded roving are laid up over a base plug and the trunk body is forced down over it. The trunk body is lifted from the cured plug, turned upside down on a flat platen, and the antenna trunk cap formed around it of another 12 plies of roving.

The antenna trunks can be used with a conventional horizontal antenna or with a 40-ft. vertical whip antenna newly developed by Mackay Radio & Telegraph Co. Inc., Clark, N. J. The RP trunks are specified in all new ship construction administered by the Maritime Administration, including the *N. S. Savannah,* world's first nuclear-powered merchant ship.

Credits: Polyester resins by Durez Plastics Div., Hooker Chemical Corp., N. Tonawanda, N. Y., woven glass roving supplied by Fiber Glass Industries Inc., Amsterdam, N. Y.; antenna trunk developed by Texaco Experiment Inc., Richmond, Va., in conjunction with Mobjack Mfg. Co., Gloucester, Va.—**End**

Two-color signs—without paint

The newest twist in signs is an extrusion-laminated two-color butyrate sheet that can be formed and decorated, without the use of paints or other decorative coatings, simply by wet sanding the formed sheet (see diagram, to right). The new process eliminates the waiting period normally required between the application of two coats of paint (one for the background of the sign, the other for the decoration). Thermoforming and decorating operations can be carried on almost simultaneously: as one sign is decorated, another can be formed, speeding manufacture and reducing storage problems. Chipping and flaking are eliminated, since the entire sign is butyrate.

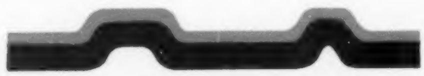
This latest advance in sign-making is the result of new techniques for producing extrusion-laminated butyrate sheet in wide widths—and at low cost. Press-laminated two-color butyrate sheet has been available in relatively narrow widths for several years. Also, variegated butyrate sheet continuously produced by crosshead extrusion has been popular for spectacle and sunglass frames. Either the press-laminated method or the crosshead-extrusion method could be used to produce sheet wide enough for sign makers. However, press-laminating is slow and expensive; and crosshead-extrusion requires two extrusion machines and special dies which are large and costly. Thus, a need has existed for an economical continuous process for producing wide, two-color, laminated thermoplastic sheet.

Now, in a process developed at Eastman Tenite Development Laboratory, Kingsport, Tenn., one sheet of butyrate can be continuously extruded onto a thinner-gage sheet in a different color so that the two sheets fuse together. The process uses essentially the same extruder set-up as that for conventional butyrate extrusion, except that a calender roll is added to do the actual laminating.

Currently, two companies are producing such laminated sheet on a commercial basis: Jet Plastics, Los Angeles, Calif., and Rowland Products Inc., Kensington, Conn. Thicknesses range from 45 to 125 mils. Sheets of any length are being offered in maximum widths of 24 inches. But larger dimensions are on the way.

How two-color sign is produced

Duplex stock is produced by laminating two butyrate sheets of different colors together.



The butyrate laminate is thermoformed on standard equipment to produce raised letters.

Surface of raised letters is sanded away, allowing second layer of color to show through.

How two-color signs are made

Backlighted signs with excellent light transmission and long-distance legibility can be fabricated easily with this new sheet. In producing a two-color sign face from duplex butyrate sheet, the sheet is first thermoformed, with the thin layer of color on the face side. After removal from the mold, the flat raised surfaces are then wet-sanded to remove the thin layer on top and expose the layer of different color beneath.

The same process can be used to make a one-color duplex sheet for backlighted outdoor signs. This is accomplished by extruding clear-transparent butyrate for the heavier bottom layer and laminating to it a thinner colored sheet. This produces a sheet of only one color when light is transmitted through it from either side. By extruding and stocking rolls of thin sheet in different colors and shades, the sheet manufacturer obtains tremendous flexibility for producing one-color duplex sheet in various tints. Thus, the only large resin inventory the sheet manufacturer need maintain is for transparent sheet.

One-color duplex sheet can be used also for fabricating sign faces of two or more colors. By sanding off the thin, colored layer from the raised surfaces of the formed sign face, the transparent thicker layer is exposed. The clear, sanded-off areas can then be painted or lacquered on the reverse side to produce the desired contrasting color or colors in the sign face.

Extrusion equipment for producing the duplex butyrate sheet includes the conventional extrusion machine, sheeting die, cooling rolls, and

TYPICAL SIGN formed from two-color duplex butyrate sheet. Method by which it was made is shown on the opposite page.

take-off rolls. In addition, a laminating roll is needed. A calender roll of chrome-plated steel, with water cooling, serves this purpose.

Method of lamination

To produce the lamination a roll of thin colored sheet is mounted as a feed roll below and behind the lips of the sheeting die. As the thicker-gage second sheet of contrasting color is extruded, the thin sheet is fed upward to meet the hot extrudate at the top of the first cooling roll. Here the sheets are pressed and fused together by the laminating roll to form a single-thickness "duplex" sheet. The duplex sheet then continues around the cooling rolls and on through the pull-out rolls. It is then cut to the desired length.

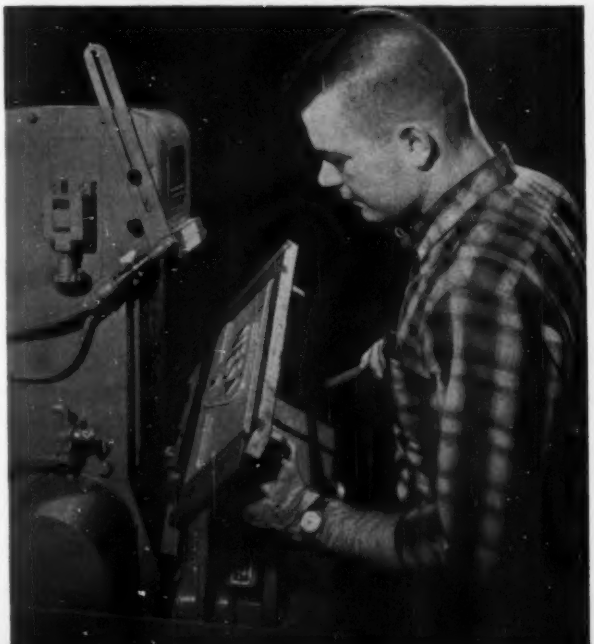
The heat necessary for complete fusion is supplied by the hot sheet, which emerges from the die at 350 to 400° F.—the normal temperature range for butyrate sheet extrusion. No special preheating of the thin sheet is necessary, since in passing between the hot die and the warm "cooling roll" it is heated sufficiently for laminating to the hot sheet.

The cooling rolls are maintained at the same temperature as those used for extruding regular butyrate sheet of the same total thickness. For duplex sheet with a total thickness of 100 mils the first two cooling rolls are heated to 170 and 210° F., respectively. Running the second roll at a higher temperature than the first roll removes any internal stresses that may be in the sheet. The laminating roll is maintained at 180° F.

For duplex sheet thicker than 100 mils, the rolls would be set at somewhat higher temperatures for slow, even cooling. Duplex sheet made up by laminating layers of 10 and 90 mils, and 20 and 80 mils, has been produced in Eastman's laboratory in Tennessee.

Total thickness of the laminated sheet is controlled by the setting of the laminating roll. Close gage control is achieved by adjusting the rate of extrusion so that a small bead of hot plastic forms at the nip of this roll. The bead should not be larger than is necessary to keep it from slipping under the laminating roll. If the bead is too large, the plastic will begin to cool. When rotation of the roll carries this cool plastic into the sheet, horizontal striations will occur on the surface.—**End**

WET SANDING of formed sheet exposes second color. Operation is faster and more economical than conventional decorating methods.



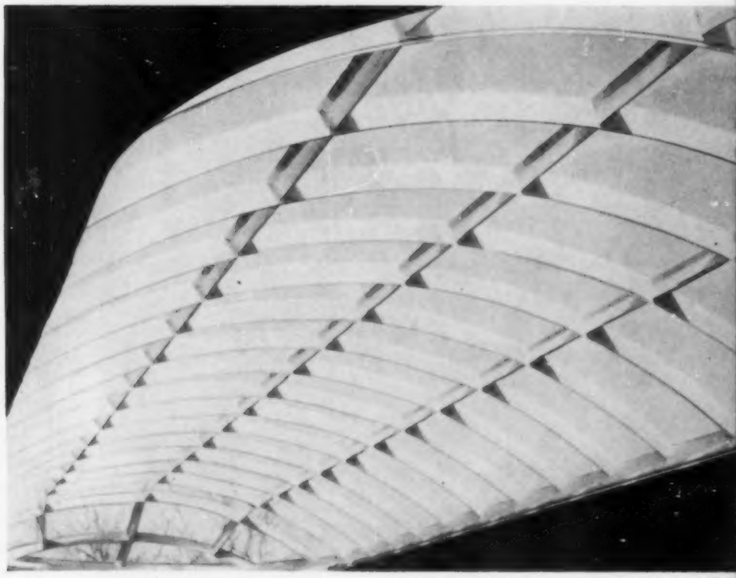
In the design and construction of a radical new aquarium building . . .

PLASTICS CREATE AN

If enough plastics "spectaculars," like the $800,000 aquarium shown above, continue to be built, then architects are surely going to have to take their blinkers off one of these days and recognize that plastics building materials are here—and here to stay. It is becoming more and more obvious that as the modern-day architect has unshackled himself from the fetters of conventional design, he has turned increasingly to plastics—at first in experimental buildings and temporary exposition halls, more recently, as the aquarium attests, in permanent public buildings.

The free-flowing lines of the aquarium, known as the Seven Seas Panorama and only recently completed at Chicago's suburban Brookfield zoo, owes much to such architectural innovations as a transparent acrylic roof supported on specially designed reinforced plastics arches; its exterior finish is a product of a unique spray-on vinyl coating; its interior appointments run the gamut from reinforced plastics bleacher seats to vinyl piping. And the poundage of plastics involved in creating just this one building is ample testament to the reasons for the plastics industry casting longing eyes at the building market. Here are some representative figures: 2000 ft. of polyvinyl chloride pipe . . . 2200 polyvinyl chloride fittings . . . approximately 1½ tons of ¼-in.-thick acrylic sheeting . . . thousands of square feet of fibrous glass cloth and several thousand pounds of epoxy and polyester resin (over 2000 lb. of polyester resin were used in the reinforced plastics trusses alone).

The Chicago architectural firm of Olsen & Urbain literally "threw away the book and wrote a new one" in creating the central building in this exhibit. It embodies a number of new concepts in materials and construction never before com-



ACRYLIC "BUBBLES" make up unique roof atop aquarium structure (left). In addition to admitting full daylight, bubbles can be removed during the summer to simulate an open air theater. Photo above shows view of roof from inside the aquarium. Supports on which bubbles rest are made of RP (see photo below).

ARCHITECTURAL WONDER

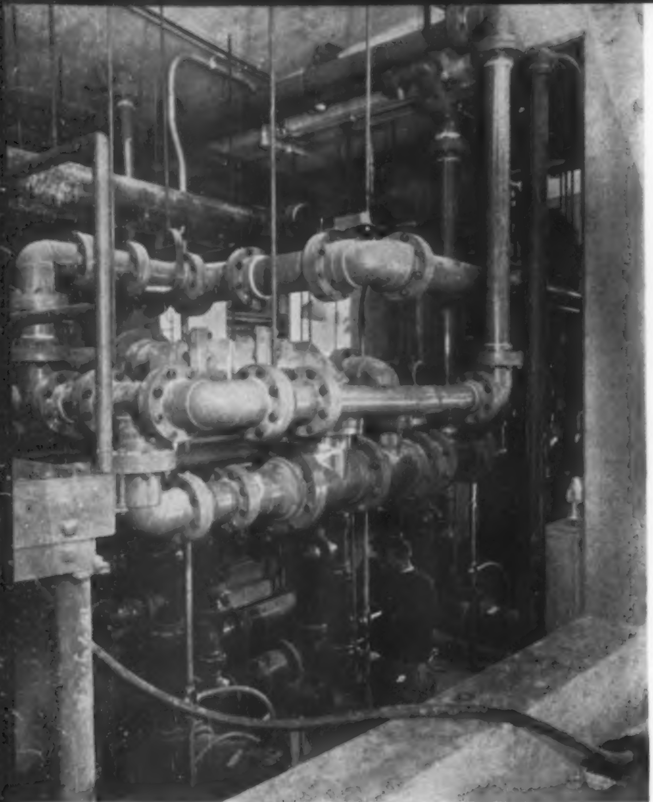
bined in a single structure. Even the use of non-plastic materials, such as sprayed concrete in combination with poured concrete slabs, involved some unusual approaches.

But it is the thoughtfully chosen plastic materials used in the new marine exhibit that engender the greatest excitement. Not only do these materials add visual appeal to the entire project, but they will also pay off through the years in considerably reduced maintenance as well as prolonged service life.

RP-acrylic roof structure

One of the most unusual and attractive plastics applications in the new Seven Seas exhibit building is the transparent acrylic roof supported on specially designed reinforced-plastics arches. The design permits the entire roof to be removed in sections for summer storage. Included in

REINFORCED PLASTICS ARCH, one of 20 which support the acrylic roof pillows, is 28 ft. long, weighs approximately 150 pounds. The 20 units required 200 lb. of polyester resin and 1500 lb. of glass cloth reinforcement.



PUMP ROOM for salt water circulation throughout pool system is a maze of PVC pipe and fittings. Some 2000 ft., ranging in diameters from 1½ to 12 in., was used along with 2200 PVC fittings. Ability of PVC to withstand corrosion at considerable savings over stainless steel, its light weight, and ease of fabrication dictated its choice here.

FORMING PIPE to a wide range of curves and twists proved uncomplicated. Here a 10-ft. length of heated pipe is curved around wood mandrel to desired configuration. Pipe was first filled with heated sand to prevent kinking or necking down.

the roof area are approximately 3000 lb. of ¼-in.-thick acrylic sheet material.

Seventy-six free-blown domes or "pillows" make up this unique roof. Most of the domes, formed from sheets measuring 67 by 102 in. in size, weigh approximately 40 lb. each.

Prior to the forming operation, each acrylic sheet is hung vertically in a gas-fired oven. To facilitate production, the fabricator constructed a Masonite-surfaced table the same height as the mold. The heated sheet is lowered onto this surface and slid immediately into the mold. The table surface is pre-heated to keep heat losses to a minimum. (For another method of free-blowing domes, see MPl, Dec. 1960, p. 92.)

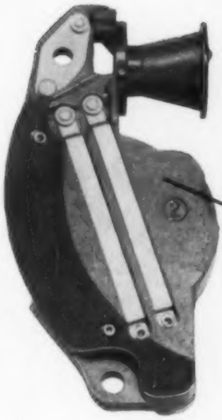
The press in which the acrylic domes were formed was specially designed and constructed by Multiplastics Co., Addison, Ill., which handled all plastics work on the project except for the plumbing and the exterior spray coating. A special clamp arrangement was used to clamp the sheets at the edge and shape the margin of each bubble to the desired contour. A Microswitch arrangement mounted above the sheet controlled air pressure cut-off, automatically halting formation of the domes when they had reached the desired height.

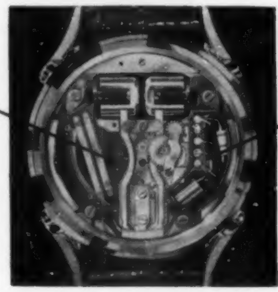
The 20 arch-like truss structures on which the transparent bubbles are mounted in multiples are of RP construction. Fabricated by laying up fibrous glass cloth in plywood female molds, the 20 units required approximately 2000 lb. of polyester resin and 1500 lb. of glass reinforcement. Each truss section is 28 ft. long and weighs about 150 pounds. The dome-truss assembly is gasketed and bolted together, and intermittent openings are used along the edges of the acrylic sheets to prevent condensed moisture from building up and forming ice deposits. When installed on the top of the pool building, the plastics roof sections are held down at each end by anchor bolts and heavy turnbuckles which permit quick erection or removal of the entire roof.

More than 30 elliptical windows, measuring approximately 3 by 4 ft. in size, are also blown of acrylic sheeting. These windows are spaced all the way around the building behind the top row of spectator benches. Contoured slightly to fit the curve of the building, they are mounted in aluminum frames and are removable in summer.

The central building houses a 25- by 100-ft. tank surrounded by amphitheater-type seating for 800 spectators. The bleacher seats, of 1½-in.-thick laminated plywood, were completely covered with a glass cloth-polyester skin before installation. Several pastel colors **(To page 174)**

GLASS-FILLED DAP MOLDINGS form two coil forms which house entire electronic works of new watch. Colored lines locate their position in movement, shown actual size. Walls of moldings are but 0.004 in. thick.





Miniature moldings for electronic wristwatch

Diallyl phthalate, moldable to extremely close tolerances, helps make possible a new concept in timepieces

In what is claimed to be the first use of plastics in the movement of a wrist watch, two parts transfer molded of a diallyl phthalate resin-based compound are put to work in the Accutron, an electronic transistorized wrist timepiece recently introduced by Bulova Watch Co. Inc. No better evidence could be found of plastics' importance to successful miniaturization—a design concept that seems to be making more and more of an impact on today's consumer goods.

The two DAP (diallyl phthalate) components are used as the chassis for the complete coil assembly, which contains the transistorized circuit and all electrical connections. An integral part of the assembly chassis are two minute coil forms. Around each is wound some 300 ft. of 0.0006 wire (about one-fifth the diameter of human hair). Energy from a power cell, controlled by the circuit, is converted by a unique tuning fork device to mechanical movements which drive the hands.

A glass-filled (long fiber) DAP compound was specified for the tiny parts because of the materials' excellent dimensional stability, insulation properties, environmental immunity, and good working characteristics. According to Bulova, the tough but flexible plastic will not crack or become soft after a period of time. In laboratory tests these molded parts were found to withstand temperatures within a range of —70 and 100° C.

The good working properties of DAP also allow the parts to meet the critical tolerances of the assembly housing. The walls of each coil form are 0.004 in. thick, and the entire circuit and mechanical assembly is ½ cu. in. in size.

The plastic parts housing the coil forms and circuit comprise one "module" unit, which can be removed and replaced as a complete unit. This modular-design approach permits watchmakers to make repairs without a knowledge of electronics.

The Accutron has only 12 moving parts, produces a hum instead of a tick, and is said to be 10 times as accurate as conventional timepieces. The unique timing mechanism of the Accutron already has had a role in space electronics. An 8-oz. device based on its design replaced 30 lb. of timing equipment in the Explorer VII satellite. For diallyl phthalate, already in wide use in electronics, this application was a natural.

Credits: The DAP compound was supplied by Mesa Plastics Co., Los Angeles, Calif., using Dapon resin produced by Food Machinery & Chemical Corp.—**End**

Blow molding fundamentals

How to design heads, dies, and molds and operate them for optimum performance

By David Schmidt†

A great deal of information has been published concerning the advantages and disadvantages of a large range of different types of blow-molding machines now being manufactured by various companies. Along with this information, typical output rates, based on extruder size, mode of operation, and the number and types of molds, are presented. In most cases, the specified rates claimed can actually be obtained in practice. However, peak performance is usually not possible unless the user gives the proper consideration to the design of extrusion heads, dies, and molds and also has a complete understanding of the extrusion characteristics of the thermoplastic that is being processed.

The user of these machines should also remember that no one type of blow-molding process stands out above all others in its ability to handle all possible product sizes and designs. For example, there is not, at present, one single blow-molding process or machine that can cover the range of versatility required to mold both 1-oz. and 50-gal. containers in the same unit, without suffering a severe loss in machine efficiency.

However, within the capabilities of the blow-molding machines available, it is possible to increase the efficiency of the machine and the quality of the product by employing fundamental engineering principles in the design of the machine components. During laboratory and field investigations of the blow-molding characteristics of high-density polyethylene several basic relationships were developed which have been useful in designing machine components such as the head, parison, die, and molds.

This article presents the information developed in the above studies, and indicates how design and operating variables influence the quality of the finished item. Although most of the work was done using high-density polyethylene, the information is basic enough in character to permit the application of these principles to other materials.

Head and die design

All blow-molding machines, with the exception of the injection-transfer type and those which blow an object from a pre-form, have an extrusion head from which the parison is extruded. Since the design of this head can play a large part in determining the quality of the parison, and hence the product, its design should receive careful attention. The important factors in head design are discussed in the following paragraphs.

Streamlining. All inside surfaces of the flow channels within the head, including the die and the core, should be well polished to prevent any hang-up of the polymer flowing melt over these surfaces. If

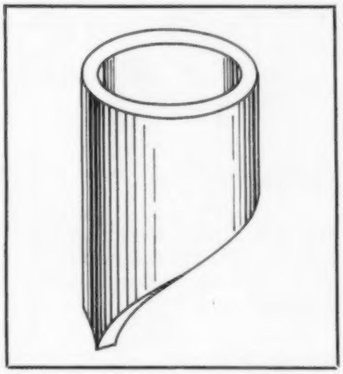
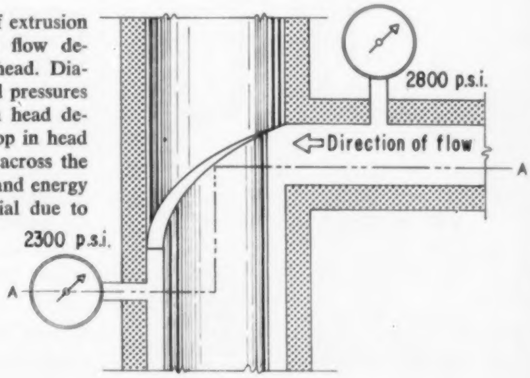


FIG. 1: Helical flow deflector which is used to streamline flow of polymer melt in blow molder extrusion head.

FIG. 2: Schematic section of extrusion head showing how helical flow deflector is mounted in the head. Diagram also shows where head pressures were measured in extrusion head design investigations. Note drop in head pressure which takes place across the head due to frictional drag and energy losses in the flowing material due to changes in direction.



* Reg. U. S. Pat. Off.
† Technical Service Engineer, Technical Service Laboratories, Polymer Chemicals Div. of W. R. Grace & Co., Clifton, N. J.

the surface of the flow channels is rough, stagnant films of the polymer may form; this material will eventually degrade, causing lines or dark streaks to appear in the parison. In addition to contaminating the finished product, roughness in flow channels may also cause the parison to rupture or blow out in affected areas during its expansion in the mold. Streamlining the shape of the flow channels also helps to avoid areas of stagnation and polymer degradation. It also aids in homogeneously reuniting or welding the hot melt after it has been split by the inner mandrel in the head. It is at this point, where the material rejoins after entering the head from the inlet channel from the extruder and flowing around the core-support mandrel, that a small pocket of stagnant material can form if the flow channel in the head has been improperly designed or streamlined. This stagnant pocket of material will then continually bleed degraded material into the "weld line" of the parison.

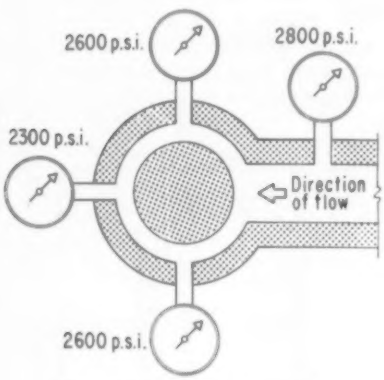


FIG. 3: Section A-A from Fig. 2, p. 105, showing pressure differences at various points in the extrusion head.

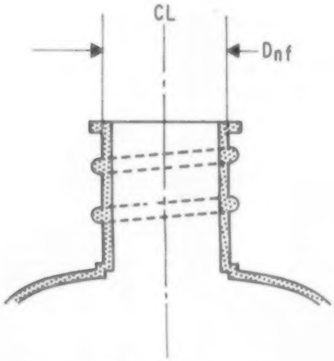


FIG. 4: Sketch showing neck finish on a blow-molded bottle. D_{nf}, minimum neck finish diameter, limits the O.D. of the parison which can be used when no pinch-off is allowed in the neck finish area.

One of the best ways to eliminate this pocket is to insert in the internal annular bore or flow channel of the head a helical flow deflector with its convergent point machined to a knife edge. It is important that this edge be as sharp as possible. This device will then allow a smooth, free sweep of material without the formation of a stagnant pocket. A sketch of the flow detector which was used with excellent results in the work reported herein is shown in Fig. 1, p. 105. A helical angle of about 45 to 50° is used to generate the helix and the flow detector is mounted in the head with the knife edge on the side of the parison core diametrically opposite the plastic melt inlet channel, about ⅝ to ¾ in. below the centerline of the inlet channel.

Healing of the "weld line" in the hot melt depends on three factors; retention time in the head, head temperature, and melt pressure. The most critical variable is time. Sufficient retention time must be provided to allow the molecules of the hot plastic to entangle and cohere. Increasing head pressure and temperature will aid this process, but their effects are of a lesser help than an increase in time to allow the knitting melt-homogenization process to go to completion.

To increase head pressure, a "choke" or annular restriction is often placed concentrically on the core in the extrusion head downstream from the flow deflector. The "choke" is, in essence, a dam which decreases the cross-sectional area of the annular flow channel in the head and builds up melt back pressure in the weld area just past the flow deflector and upstream from the "choke." However, it has been found that the use of chokes and increased head pressure without the streamlining afforded by the flow deflector is not effective in producing optimum weld conditions.

The use of a choke may sometimes create problems in parison extrusion. However, when a choke is used every effort should be expended to maintain uniform streamlining in the flow channels so that none of the plastic material flowing through these channels will be able to cause hang-up problems. It is sometimes possible for small, hard, carbonized particles of degraded polymer or hard gels in the material to become trapped in non-streamlined channel designs.

Flow equalization. Basically, the part being produced in the extrusion type blow-molding machine will have a quality as good as the parison which is produced by the extrusion head. Therefore, it is extremely important that the thickness of the wall in a transverse or circumferential section through the parison be as uniform as possible so that the part being blown will also have a uniform wall thickness. It is important that the wall thickness of the parison be uniform not only in the transverse cross-section but also in a cross-section taken in a longitudinal fashion through the axis of the parison, that is, in a direction which is coincident with the direction of flow or in the vertical direction of extrusion.

Obtaining this uniformity requires complete and careful control and balance of the melt flow in the head; proper uniformity will not be obtained simply by controlling the die and core areas alone. The die and core act purely as mechanical devices which determine the size of outside and inside diameters of the parison, which dimensions are dictated by the weight and geometric configuration of the item being blown. The die and core must, of course, be positioned with their center lines coincident. In this respect they do contribute to wall uniformity. However, even when they are perfectly concentric, variations in wall thickness can occur due to imbalances in melt flow.

To promote uniformity of parison thickness, careful consideration should be given to those areas in the extrusion head where changes in flow direction take place. Linear polyethylene, which has a molecular structure of long-chain molecules with few branches, is more sensitive to changes in direction of flow and the creation of velocity gradients in the melt than the conventionally branched low-density polyethylene. The reason is that the unbranched chain-like molecules in the hot melt state can easily slip

Typical values
of percentage swell
for various polyethylenes

Phillips type linear	15 to 40
Zeigler type linear	25 to 65
High-pressure, low-density	30 to 65

along their individual planes if there are any factors causing internal differences in melt flow velocity. Low-density, or branched PE, is less affected by velocity differentials, as branched molecules are intermeshed and tend to drag each other.

Velocity differentials in melt flowing in a straight channel or in melt undergoing a change in direction are generated by frictional drag on the melt at the channel surface and by pressure drops arising from losses in the kinetic energy of the flowing melt. The pressure drops and frictional drags are proportional to the distance that an increment of the polymer must travel within the channel and the rate of shear. Pressure loss becomes especially evident in the head of the blow molding machine because of changes in the cross section of the flow channel in the head and the 90° change in the overall direction of the melt as it flows from the horizontal extruder and out of the vertically oriented parison die. In addition, the inlet flow of the melt is diverted around a mandrel. Pressure readings taken in the extrusion head of a blow-molding machine at points 90° apart, slightly below the 90° elbow, show a pressure differential between the melt-inlet side of the head and the approach to the parison die orifice of greater than 200 p.s.i. See Fig. 2, p. 105. This pressure differential changes the viscosity of the melt shear rate and, along with changes in cross section, the velocity of the polymer. The greatest melt velocity and shear rate are at a point directly below the circular melt-inlet channel; here the head pressure is greatest, also. The shear rate in the melt and the melt's velocity diminish to the lowest value at a point diametrically opposite the melt-inlet channel. See Fig. 3, p. 106.

It is at this location, slightly below the inlet channel, that the chokes are placed to control this non-uniform flow by creating a high back pressure which slows down the flow on the inlet side of the "core bridge." Most chokes are ineffective in this respect. The design and positioning of the core to produce a uniform flow is quite dependent on other factors such as overall machine design, the extruder and its specific output rate, and the back pressure developed.

A choke, to be properly and correctly designed, must compensate for the various differences existing in polymer pressures and shear rates: it must also take care to avoid any possible creation of conditions of turbulence in the melt itself. Unfortunately, there are not, at present, any known theoretical or empirical formulae which will enable the design engineer to accurately predict the type and the amount of melt flow imbalance in extrusion pressures or rates of shear which one can reasonably expect to experience in actual practice with any one of several given head designs. Since this pattern of flow imbalance must be predicted with a certain degree of certainty to permit an intelligent approach to the design of an extrusion head, the actual flow patterns in a proposed head design must be determined experimentally in a trial and error fashion. The results obtained with a head of about the design desired are then used to make successive head design alterations to bring the internal head flow patterns into balance.

Once uniform flow conditions have been established in the extrusion head, the next consideration is the control of the flow leading to the die orifice. Traditionally this "angle of approach" has been accomplished with a taper. It is this approach which is recommended for most applications.

Based on experiment it has been found that for polyethylene with densities of 0.945 and higher the maximum included apex angle of the conical approach channel, or "angle of approach," should be 35°, and that the ratio of annulus width at the die orifice to length of land should be a minimum of about 8 or 10 to one. This combination of head and die design was found to work most satisfactorily. If materials other than high-density polyethylene are used, the recommendations should be reviewed with the materials supplier.

Die and mandrel calculations. The next step in the design of the head and die is the sizing of the diameters of the die and parison-support mandrel. One of the most important factors in "free extrusion" blow molding is the use of the proper size die and mandrel combination. However, several variables must be taken into consideration before the die and mandrel sizes can be calculated. The two primary variables are blow ratio and percentage swell.

Blow ratio, for the purposes of the calculations to follow below, is defined as the ratio of the maximum outside diameter of the finished molded part (or the maximum outside dimension in the case of parts with non-circular cross-section) to the maximum outside diameter of the parison after the parison has emerged from the extrusion die and relaxation or "swell" has taken place. Normally it has been found to be most desirable to keep the blow ratio in the range of approximately 2 or 3 to one.

This range is well within hot melt elasticity limits of most polyethylenes and, with its use, the parison has less of a tendency to blow out unequally due to variations in

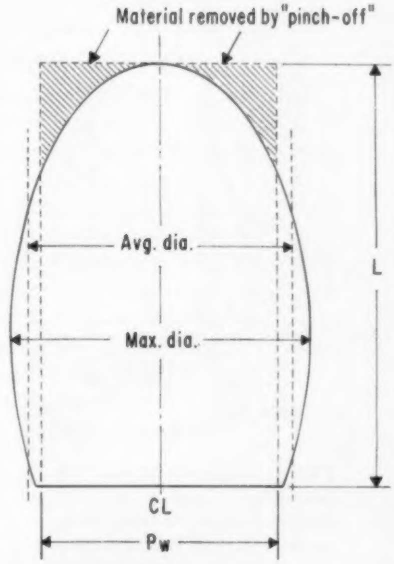


FIG. 5: Schematic drawing of an actual blow-molded item which was used to check formulas developed for calculating die and mandrel diameters. Pinch-off width, P_w was the limiting dimension in the calculation.

thickness of the parison wall or non-uniformity of temperatures within the material of the parison itself.

However, in actual practice it is not always possible to maintain this ratio of part diameter to parison diameter. In fact, in the majority of cases, the dimensions of the part which determine the actual diameter of the parison to be extruded will be the pinch-off width desired or the requirement that the diameter of the parison be equal to the neck finish diameter (D_{nf} in Fig. 4, p. 107) of a bottle or similar object. This is done so that the parison may be confined within the diameter of the neck finish when the mold is closed on the parison. The latter technique of molding is called "inside-the-neck" blowing. This type of blow molding is quite prevalent in the bottle field. It is used because manufacturing specifications usually require that there be no flash, or pinch-off, on the neck finish. Since the neck dimension is controlling, it is not uncommon in this method of molding for blow ratios to range as high as 5:1 or 7:1 to satisfy the required dimensions in other areas of the part.

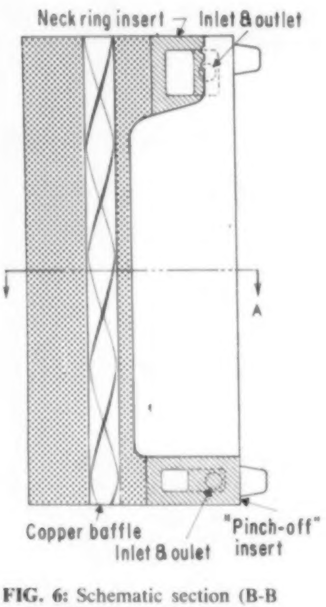


FIG. 6: Schematic section (B-B from Figs. 7 and 8, p. 110) through one-half of typical bottle mold showing twisted copper strip baffles used in the body of the mold. Also shown are sections through neck ring insert and pinch-off insert illustrating shape of insert cooling channel. Top view of the mold is shown in Fig. 7, while Section A-A is shown in Fig. 8.

The percentage swell of the extruded parison is defined as the actual, relaxed diameter of the parison (after it has left the extrusion die) minus the diameter of the extrusion die, expressed as a percentage of the diameter of the extrusion die. The amount of swell which takes place in the parison as it flows from the die is dependent on the following factors:

1. Rate of extrusion or shear rate.
2. Cross-sectional area of the die orifice.
3. Type of material extruded.
4. Plastic melt temperature.
5. Length of die and mandrel lands.

The combination of the cross-sectional area of the orifice and the length of the die and mandrel lands will interact with, and leave a significant effect on, the shear rate of the material. The combination of shear rate and melt temperature are also important since they will affect both the relaxation that occurs in the melt and the melt's tensile strength.

When a polymer is forced through an orifice, the molecules orient in the direction of flow. As the polymer exits from the die, the molecules relax to their original random orientation. This results in a shrinkage in length and a swelling in the diameter of the parison. Increasing the material temperature and decreasing the shear or extrusion rate (lowering head pressure) will decrease the amount of swelling that takes place. This is due to the increased ability of the molecules to relax thus decreasing the amount of orientation that takes place in the melt as it flows from the head. Sag and draw-down of the parison can also affect the swell of the parison and are dependent on the tensile strength of the molten resin. Decreasing the melt temperature, or decreasing the time (including extrusion time) that the parison hangs under its own weight prior to blowing will reduce the amount of sag, and usually increase swelling somewhat. Increasing the viscosity of the melt by using resins of lower melt index also increases swell. Highly branched resins and lower-density polyethylenes have higher melt tensile strengths which decreases sag and contributes to swell. Melt tensile strength may also be increased by increasing the viscosity of the melt or by using lower melt index resins.

It was only possible, with the methods now known, to obtain approximate ranges of percentage swell values for the range of resins of different densities and melt indices that are used today in blow molding. This is due to the complexity of factors entering into the picture, as indicated above. Typical values of percentage swell developed from experience for various types of high-density polyethylene are shown in the table on p. 107. Ranges shown give only a general indication of the percentage swell to be expected. Therefore, to make accurate die and mandrel calculations using the formulae presented below, it is strongly recommended that the variation in percent swell with extrusion rate, temperature, and orifice openings be determined by each user of the formulae for the particular type of resin in which he is interested.

To calculate the diameter of the die where the pinch-off width is the controlling dimension, the formula shown below has been developed from an analysis of the geometrical relationships between the pinch-off width, die diameter, and the swelling characteristic of the plastic material. It can be shown that:

$$P_w = \frac{\pi D_d\ (S/100 + 1)}{2} \qquad \text{Eq. 1}$$

or

$$D_d = \frac{2\ P_w}{\pi\ (S + 1)} \qquad \text{Eq. 2}$$

where

D_d = Diameter of the die, in.

P_w = Pinch-off width + 2 Parison thicknesses, in.

S = Amount of swell, 0/0 ÷ 100

By a similar analysis, the diameter of the die in the case where the parison must be contained inside the neck finish of the mold can be estimated by the following relationship

$$D_d = D_{nf}\ (1 - S) \qquad \text{Eq. 3}$$

where:

D_{nf} = Minimum diameter of neck finish required, in. (See Fig.

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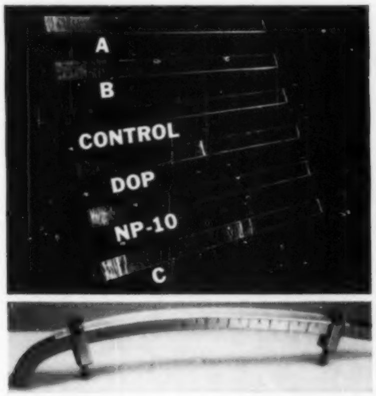

Crazing and staining of polystyrene surfaces in contact with plasticized vinyl moldings and extrusions now can be virtually eliminated by using Polymeric Plasticizer NP-10.

In the test illustrated above, polystyrene strips, after being carefully molded and cured, were put under stress in an elliptical clamp. Various plasticizers, both monomeric and polymeric, were poured on the strips and allowed to remain in contact with the polystyrene for 24 hours or until fracture. The polystyrene was least affected by NP-10.

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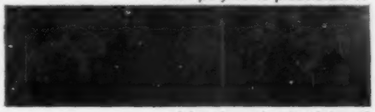
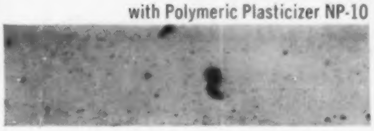


with polymeric plasticizer B

with Polymeric Plasticizer NP-10



The extremely low migration of NP-10 in vinyl compounds makes it an excellent choice where extreme conditions are to be met. In vinyl backing strips for surgical and electrical tape, for example, its use eliminates adhesive breakdown resulting from migration of the plasticizer into the adhesive.

The above vinyl films each contain 50 parts of plasticizer per 100 parts of resin. They were weathered for six months on a fence inclined 45° to the south. In comparison with two well-known polymeric plasticizers, the sample containing NP-10 shows almost no dirt pick-up because there was little migration of the plasticizer to the film surface.

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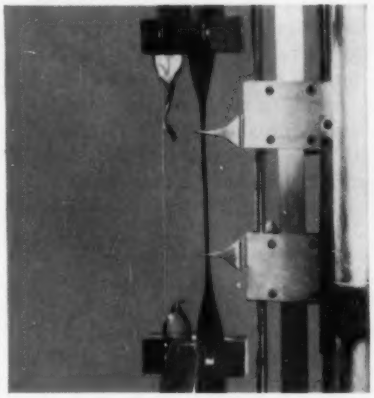

Vinyl compounds plasticized with NP-10 show little loss of plasticizer upon heat aging. Because NP-10 stays in vinyl compounds at elevated temperatures, it is an excellent choice for high temperature wire coatings and automotive dashboard deck coverings.

In the above test, the retained elongation of two vinyl compounds was determined after heat aging for 7 days at 120°C. Sample at left was compounded with 50 parts of DOP per 100 parts of resin; sample at right, with a like amount of NP-10. The sample containing DOP broke at 75% elongation. The sample plasticized with NP-10 exhibited a retained elongation of 100%.

These are but three of the advantages of this unusual primary polymeric plasticizer. NP-10 is highly resistant to hydrolysis and to extraction from vinyl films by hydrocarbons, soapy water and activated charcoal.

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4) and other symbols have the same meaning as before.

After the die diameter has been found, the diameter of the mandrel may be calculated by the following formula:

$$D_c = \sqrt{(D_d^2) - 4\,w/\pi\, L\, d} \qquad \text{Eq. 4}$$

where:

D_c = Diameter of the core, in.

W = Weight of object, g.

d = Density of the resin, g./cu. in.

L = Length of object, in.

A sample calculation is shown below to illustrate the use of the formulae. This calculation was performed in the design of an actual part having the dimensions used below. With reference to Fig. 5, p. 107, the numerical values for the object shown in the drawing are:

P_w = 4.28 in.

W = 39 g.

L = 7.24 in.

d = 15.5 g./cu. in. for 0.950 density linear polyethylene

Swell = 25% (From table)

Maximum part diameter = 4.92 in.

Average part diameter = 3.5 in.

Using Eq. 2, the diameter of the die is calculated:

$$D_d = \frac{(2)\,(4.28)}{\pi\,(0.25 + 1)} = 2.181 \text{ in.}$$

Using this value for D_d, the diameter of the core may then be estimated by using Eq. 4:

$$D_c = \sqrt{2.181^2 - \frac{(4)\,(39)}{\pi\,(15.5)\,(7.24)}}$$

or D_c = 2.077 in.

To check the consistency of the dimensions determined above and the arithmetic accuracy of the calculations, it is advisable to calculate the weight of the object that a die with the calculated dimensions will produce and then check this figure against the design weight originally assumed.

From a geometrical analysis of blow-molded items, the following formula has been found to express the weight of a blow-molded object with good accuracy.

$$W_g = \pi\, d_{avg}\, t_{avg}\, L\, d$$

where:

W_g = Weight of object, g.

t_{avg} = Average wall thickness of object, in.

d_{avg} = Average diameter of object, in.

L = Length of object, in.

d = Density of resin, g./cu. in.

The average wall thickness to be used in the above formula is found as follows: Take one-half the difference between the calculated die diameter and the calculated core or mandrel diameter (the nominal thickness of the parison). Geometrically the thickness of the parison should decrease due to the swelling of the diameter. However, in actual practice the net effect of the relaxation in the parison is to multiply this decrease in thickness, and wall thickness actually remains the same or increases slightly. Therefore, no correction in nominal thickness is made for swelling of the parison. Numerically the calculation is

$\frac{1}{2}$ (2.181 − 2.077) in. = 0.0520 in.

This is then divided by the average blow-up ratio.

The average blow-up ratio is calculated by dividing the average diameter of the object by the swollen parison diameter, or, in this case by 1.25 times the die diameter. Thus the blow-up ratio is

$$\frac{3.5}{(1.25)\;(2.181)} \quad \text{or } 1.283$$

and the average thickness is

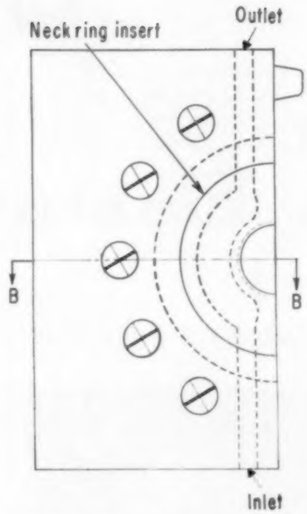

FIG. 7: Top view of bottle mold half shown in Fig. 6. Note location of baffled cooling channels in body of mold and layout of cooling channel in neck ring insert. Layout of pinch-off insert cooling channels is similar.

$$\frac{0.0520 \text{ in.}}{1.283} = 0.0405 \text{ in.}$$

Having the average thickness, the data above may be used in Eq. 5 to calculate the weight of the blown object:

W_g = (3.14) (3.5) (0.0405) (7.24) (15.5) or W_g = 50 g.

Note that this calculated weight is about 25% higher than the design weight of 39 g. which was used to calculate the die and core dimensions. However, it must also be remembered that the calculations have not taken into account the scrap material which will be produced as the mold pinches off the upper portions of the parison as shown by the shaded area in Fig. 6, p. 108. In the actual problem under consideration, the scrap was actually estimated to run about 10 grams. When this is subtracted from the 50 g. calculated above, the finished bottle weight which would be produced from a die with the calculated dimensions would be 40 grams. This compares favorably with the design weight used to estimate the die dimensions, indicating that the die dimensions will be satisfactory to produce the desired product.

If, after correcting for the scrap, the calculated weight **(To page 184)**

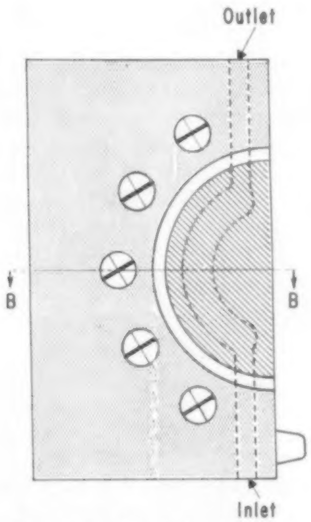

FIG. 8: Section A-A of bottle mold half shown in Fig. 6. Line shading indicates pinch-off insert and illustrates layout of insert cooling channels.

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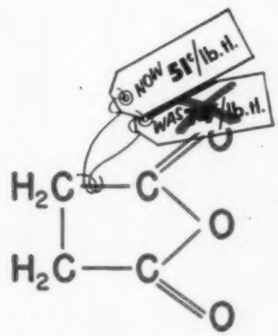

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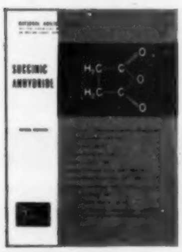

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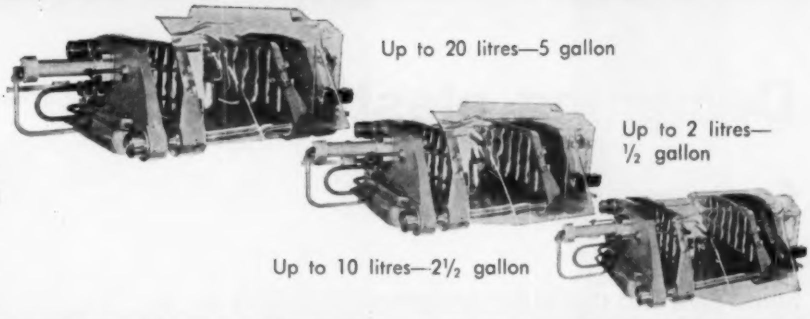

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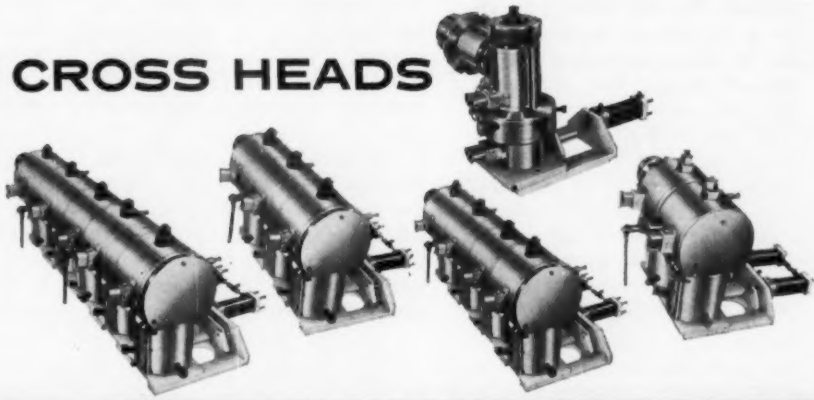

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Designing plastic parts for metallizing

Some do's and don'ts for designers and molders when planning and producing plastics parts to be metallized

By Allen Shaw*

The cost of metallizing a plastic part and the quality of the metallized finish possible depend heavily on the design of the plastic part itself. An understanding of the basic principles of vacuum metallizing is, therefore, necessary in insuring good part design.

First step in the metallizing process is to manually place the plastics parts on suitable holding fixtures or racks which will allow them to be handled efficiently through the entire production run. Racks will differ in design depending on the product handled but, in general, they will resemble the typical rack illustrated in Fig. 1, below. Following racking, the parts are base-coated. All parts to be metallized receive a base coat of lacquer to improve adhesion of the metallic coating to the part and to produce a smooth, glossy surface which will create the shiny effect of polished metal. After coating by either spray-, dip-, or flow-coat methods, the excess lacquer is spun off the racks and the coatings are baked or air dried depending on the type of lacquer used, the type of plastic being metallized, and the application requirements of the part. Once the coating is dry and hard, the parts are then ready for metallizing.

In this operation the racked parts are placed in a high-vacuum chamber (at a pressure of about 5×10^{-4} mm. of mercury) and subjected to the bombardment of aluminum atoms evaporating from a heated filament within the chamber. It is important to note that the atoms leaving the filament, which is usually placed along the center of the circle formed by the rotation of the parts, travel in straight lines, similar to light beams, and that those areas of the parts which are shielded from direct exposure will show "shadows," or uncoated areas. During the exposure in the chamber, the loaded racks are rotated to avoid underexposure. The metallizing process takes only a few moments.

Aluminum is used for the metallizing film because of its high reflectivity, rated at about 89 percent. This is only slightly less than that of a freshly polished silver surface, which has a reflectivity rating of about 93 to 94 percent, and better than chromium, which has 65 percent reflectivity. Although its original reflectivity is less than silver, aluminum is actually superior to silver for metallizing since silver tarnishes and rapidly loses its small reflectivity advantage; besides, silver is more expensive. The reflectivity of aluminum is protected indefinitely by an invisible film of

* Vacuum Metallizing Inc., 3236 Greenpoint Ave., Long Island City, N. Y.

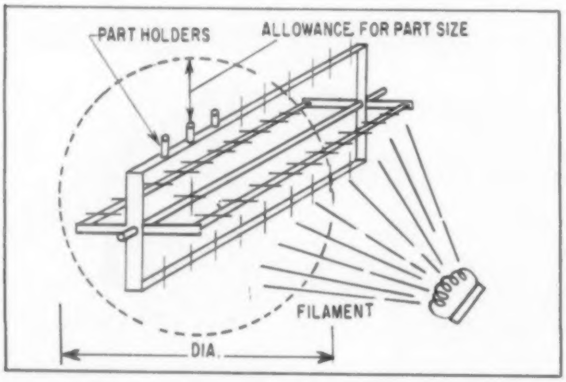

FIG. 1: Typical rack for metallizing parts. Each of the rods is equipped with holders or clips in which to mount the plastic parts. Parts holders are staggered along the rack so that no part is in front of any other part with respect to the metallic filament shown schematically at the right. Parts are also mounted so no surface to be metallized is exposed at an angle less than 45° to the line of metallic atom radiation. Diameter of the spokes, including the mounted plastics parts, range from 14½ to 20 in., depending on the number of stations in the vacuum chamber as well as the size of the chamber itself.

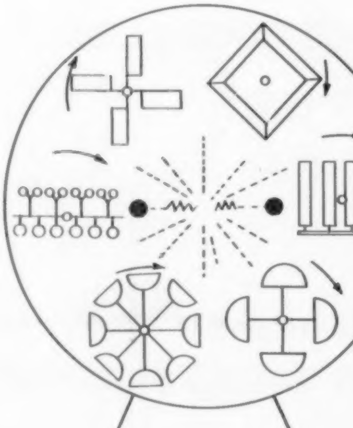

FIG. 2: Schematic end view of open vacuum metallizing chamber, showing racks with various spoke designs for a variety of plastics parts. Racks do not rotate around filament but rotate on their own axis to expose all surfaces of the part to the metallic radiation from the filament.

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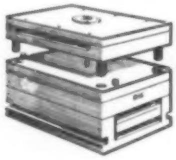

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oxide which forms as it is exposed to air on removal from the vacuum chamber. At this stage in the process all of the metallic films are silver in color.

After the metallized film has been applied the parts are coated with another lacquer to protect the thin metal film against abrasion and loss. The type of lacquer is chosen on the basis of service required of the part and the plastic on which the film has been deposited. Application is similar to that of the base coating. After the coating is applied it is dried or baked. If a gold color is desired, the top coating is dyed with a yellow color after it is dry. The racks of parts are then returned to the racking area to be unloaded and then packed for shipment.

What can be metallized

Theoretically, any plastic can be metallized, provided a suitable base-coating system is available which will adhere well to the plastic part and which will accept the metallic film. However, in actual practice, some plastics, especially the plasticized materials, are extremely difficult to metallize. For example, plasticized vinyl is virtually impossible to metallize with good results. This is because of plasticizer migration. In addition to interfering with the adhesion of the base coat, this migration also tends to poison the oils used in the diffusion-type pumps used to develop the high vacuums in the metallizing equipment. For similar reasons, cellulose acetate butyrate and cellulose acetate materials are also difficult to metallize, although they are less troublesome than the plasticized vinyl materials.

Polyolefins, such as polyethylene and polypropylene, can be metallized but require a surface pretreatment similar to that needed for printing on these materials. This pretreatment is necessary to promote good adhesion of the base-coat lacquers used. Since this pretreatment is an additional processing step it adds to the expense of the part.

Phenolic, urea, and melamine resins can be metallized, but some caution is required in their selection. For good base coat adhesion, the lacquers used with these materials must be baked at high temperatures. Since the entire part will be exposed to this temperature, the plastic compound chosen should have a heat resistance great enough to withstand the lacquer-baking cycle without a significant loss of desired properties. Care should also be used to select non-bleeding grades of phenolic resins and grades of melamines and ureas with non-bleeding colorants.

Polystyrene, fibrous-glass reinforced polyester and epoxy resins, nylon, and methyl methacrylate are plastics relatively easy to metallize.

Parts should be dried prior to metallizing and the drying operation may tend to increase costs unless the parts are delivered dry to the metallizer. Otherwise, excessive shrinkage frequently occurs in drying the lacquers.

Methyl methacrylate parts to be metallized should be stress free and may have to be annealed prior to metallizing to avoid stress-cracking under the influence of the coating solvents and the high processing temperatures.

In general, when selecting a plastic material for a product which will be metallized, the designer should remember that the part will be subjected to the solvents used in the base coat lacquers as well as to the elevated temperatures used in drying the base coat and the top-coat lacquers. Air-drying lacquers can be used but are often more expensive because of the longer drying cycle required. They may also not be satisfactory for some applications because of the softer surface of this type of coating. Typical lacquer baking conditions for plastics with low heat resistance are in the range of 150° F. for 1 hr.; for high-temperature resistant plastics they range up to 325° F. for periods of about ½ hour. These conditions are typical of those used for both base and top coats.

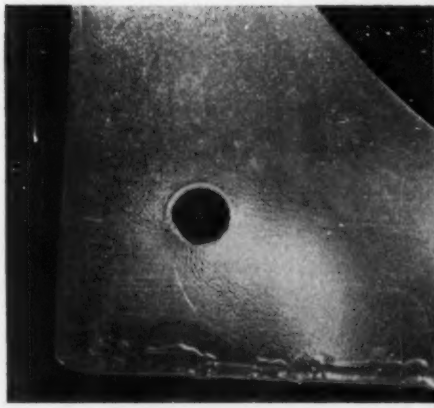

FIG. 3: Example of poor metallizing job arising out of the difficulty in coating large flat surfaces. Lacquer undercoat has developed orange peel and drips, which faults are exaggerated by applied metal film.

Top coats for metallized parts are generally selected on the basis of the service the part will be required to withstand. Usually the coating formulation will have one outstanding property such as abrasion resistance, chemical resistance, or moisture resistance. Seldom will it be possible to get a lacquer which will be outstanding in all respects,

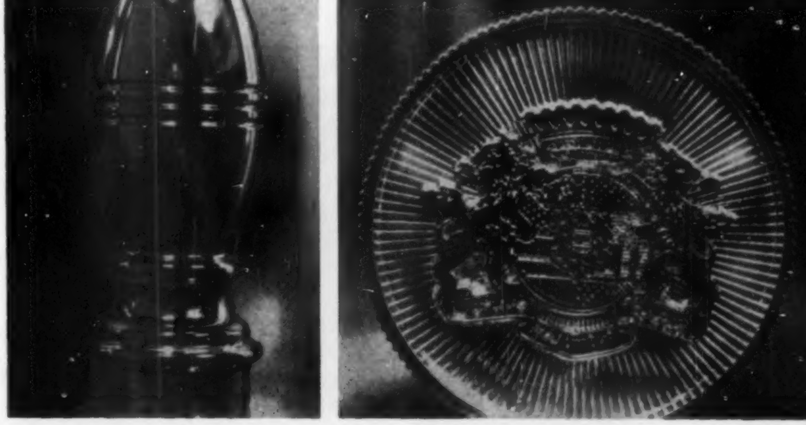

FIG. 4: Sample molded parts showing how rounded surfaces can enhance the quality of metallized finishes. At left, effect of broad rounded surfaces; at right, results obtained with fine fluting.

FIG. 5: Attractive three-dimensional metallizing effect that can be achieved through the use of contrasting smooth and broken surfaces.

and compromises will have to be made. However, the designer should remember that the lacquer-metal-lacquer coating on his plastic part can sometimes be used to upgrade the surface properties of the part over those which would be possible using the plastic part without any coating at all. The overall thickness of a metallized coating ranges from 1 to 1½ mils.

Product design

Before the designer starts actual work on a specific part he should decide whether he should even consider metallizing as a finishing process. First he should have some idea of the total number of such parts to be made. As mentioned previously, special racks are used to mount the parts for metallizing and these fixtures represent a capital investment which will be part of the metallizing cost..

Racks range in cost between $75 and $450 depending on complexity. This investment must be amortized over the total number of parts made. Sometimes it may be possible to use existing racks in the metallizer's plant. In either case, the quantity of parts to be metallized must be such as to warrant the capital investment required for new tooling or the charges for the use of existing racks. The best approach to this question is to contact the metallizer. Let him know the required number of parts, find out what tooling charges can be worked out, and determine whether the metallization of the required number of parts can be done at a reasonable cost. From the metallizer's standpoint, if new tooling is required, it is, as a rule of thumb, not advisable to metallize unless the total run is at least 50,000 pieces of relatively small parts.

Another factor to consider in deciding to use a metallized finish is the over-all size of the part. Common sizes of vacuum metallizing chambers have diameters of 10, 18, 24, 48, 66, and 72 in. and range from 4½ to 6 ft. long. All the units have 1 to 10 rack-rotating devices of various types within the chamber diameter. (Fig. 2, p. 114.) The size of the part to be metallized will determine how many parts can be metallized per chamber load. This, in turn, will affect the rate of production and the metallizing costs. The larger the part, the fewer per load, the lower the production rate, and the higher the cost. Again, the designer should consult with the metallizer to determine if the cost of metallizing the contemplated product will be excessive.

Once it has been decided that the product is of the right size and will be made in sufficient quantity, the product should then be designed so that metallization can be carried out most efficiently and with the best results.

Checklist of do's and don't's

Out of experience with many plastics part designs there have evolved several basic rules which the product designer can follow. These will facilitate the metallizing of the plastic part and generally reduce the metallizing cost.

1. Do not use large flat unbroken surfaces. Anything over 2 by 2 in. would be considered a large area. Since none of these surfaces can usually be molded optically flat, there is always some uneveness or distortion in the surface. When metallized, this surface distortion is magnified and becomes plainly visible. The flat surface will also interfere with base coat run-off and may

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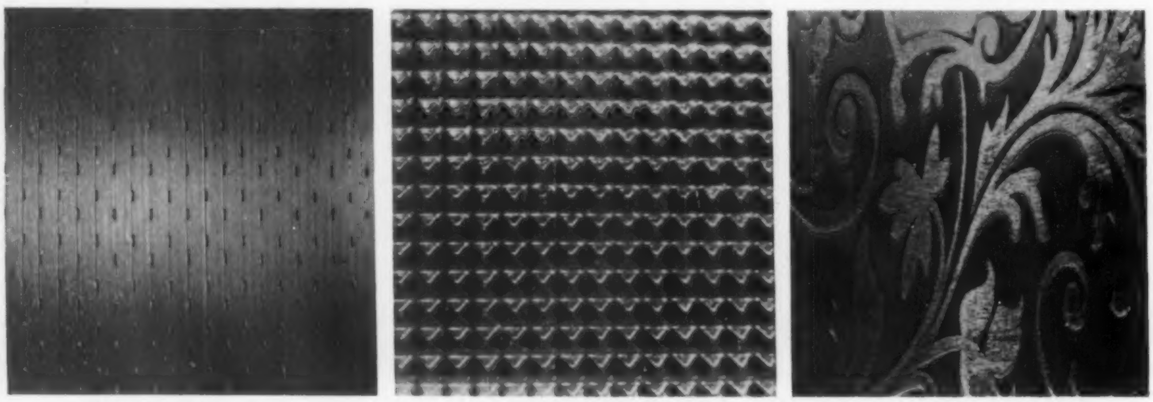
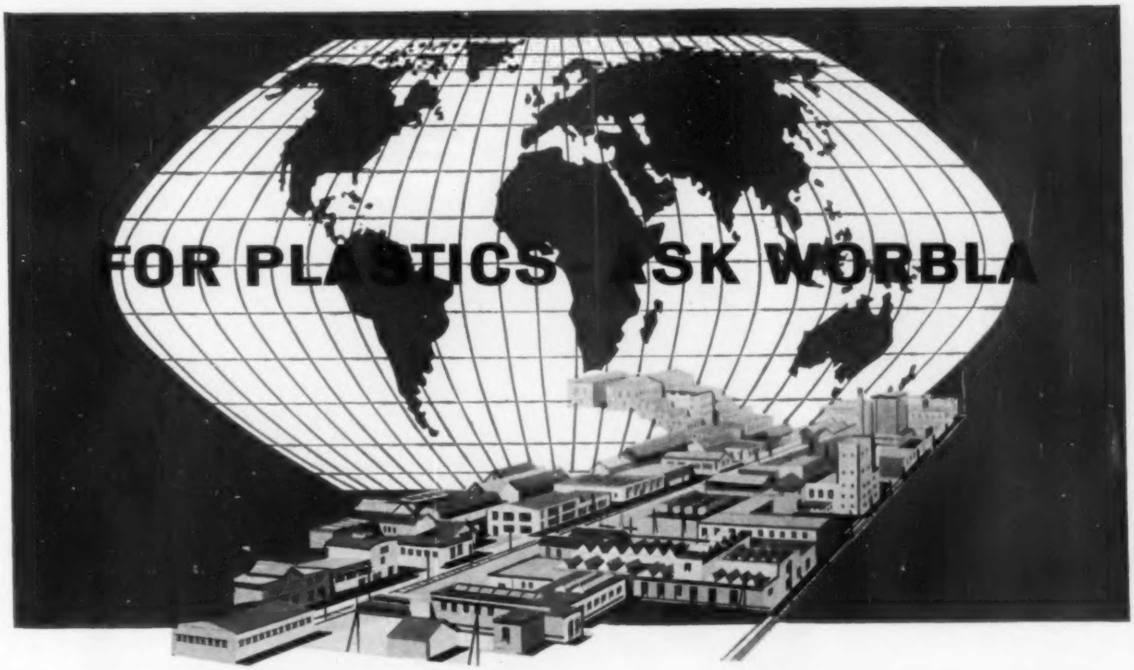


FIG. 6: Parts demonstrating the use of engine turned, embossed, and brushed surfaces to enhance the appeal of metallized finishes and to hide any minor defects in the molding.



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result in visible flow lines and drips. Fig. 3, p. 117, illustrates the poor quality of metallized finish which may occur as a result of metallizing flat surfaces.

2. Make generous use of rounded surfaces, such as ribs and flutes in the part, as shown in Fig. 4, p. 117. The smaller the radius of curvature, the better. Broken surfaces display brilliant highlights and promote better base coat run-off.

3. Avoid specifying those surfaces of the plastic part for metallizing which would be prone to molding sink marks due to studs, plugs or walls butting into the underside of the metallized surface.

4. Try to incorporate as much three-dimensional detail as possible, keeping in mind that startling and smart effects are always produced by contrasting highly polished and dull surfaces. For an example of this technique, see Fig. 5, p. 118.

5. Avail yourself of the mold-finishing techniques of engine turning, stippling, hammer tone, embellished design, vapor blasting, and etched and cut patterns on the flat portions, leaving rounded surfaces clear and smooth. (Fig. 6, p. 118.)

6. Stay away from the use of fine or feather edges on the parts. It is difficult to get a good base coat on such edges and adhesion of the finish will suffer.

7. Do not use deep, narrow depressions or slots in the part design since it may not be possible to get enough metal down in between the slot walls. If the slots are too narrow they may also become clogged with lacquer in base coating. A simple rule is to maintain a 1:1 ratio between the width and the depth of the slots.

8. Do not design parts with long unbroken surfaces of very thin wall sections. Since the parts may go through as much as 3 hr. of total baking at elevated temperatures in base-coating and top coating, warping of the part may result.

9. Do not design parts which will require the use of a mold cavity with so little side wall draft that a lubricant will be necessary to eject the part from the mold. Mold design must be such that no lubricants will be required or used. This point cannot be overstressed since any lubricant on the surface of the part to be metallized will interfere with base coating, causing poor adhesion of the lacquers and a high reject rate in the operation.

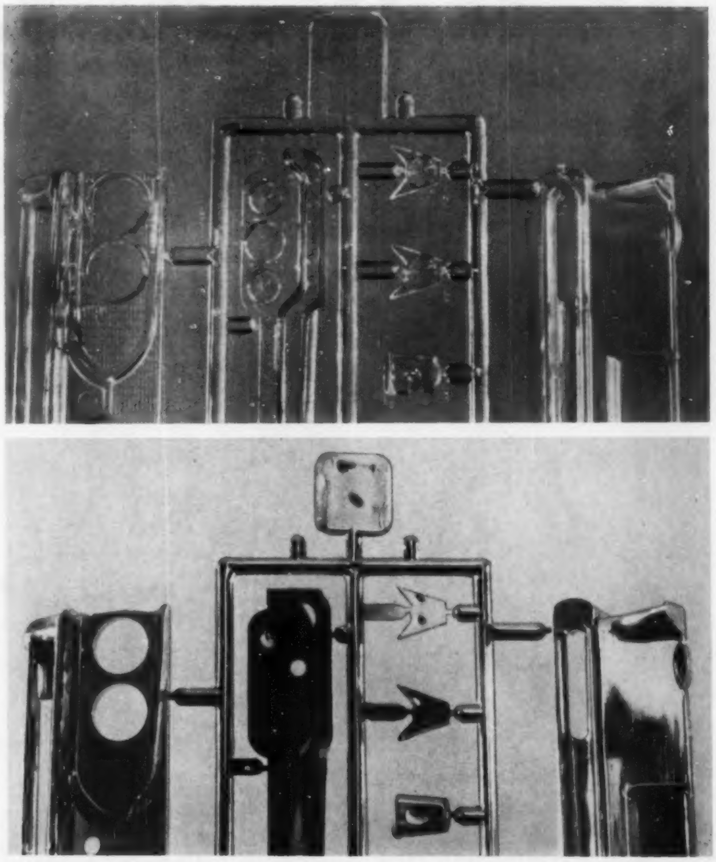

FIG. 7: Injection molded polystyrene toy automobile parts shown with runner system still attached. Note double gating used on several parts to provide additional support for the parts when being handled in the metallizing process. Tab at top of posts used to rack the parts for metallizing was changed to provide additional strength (top) to avoid breakage in racking. Part at top has not yet been metallized.

Obviously the mold must be designed to incorporate the part design features mentioned in the preceding section. In addition, the mold designer should use care to locate knockout pins, parting lines, and mold section demarcations which will appear on the part so that, if possible, they will not appear on the decorative metallized surface. Any such mark from the mold surface will be transferred to the part and although it may not be objectionable in an unmetallized part, the metallized coating will serve to magnify the marks on the parts and make them plainly noticeable.

Care should also be taken to lay out the parts and runner system so that flow lines and weld marks will be minimized, **(To page 191)**

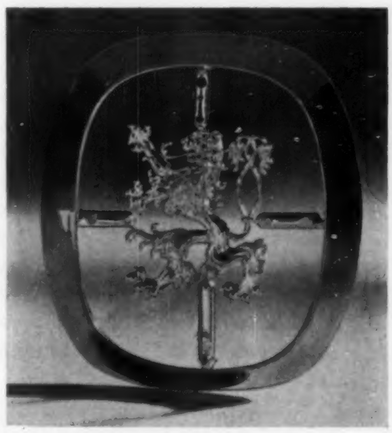

FIG. 8: Metallized plastic part showing how mold and runner system were designed to save space in racking by placing one part within the other. This technique also assures that both parts will be metallized at the same time so that their colors will also match exactly. Simultaneous metallizing also reduces over-all costs.

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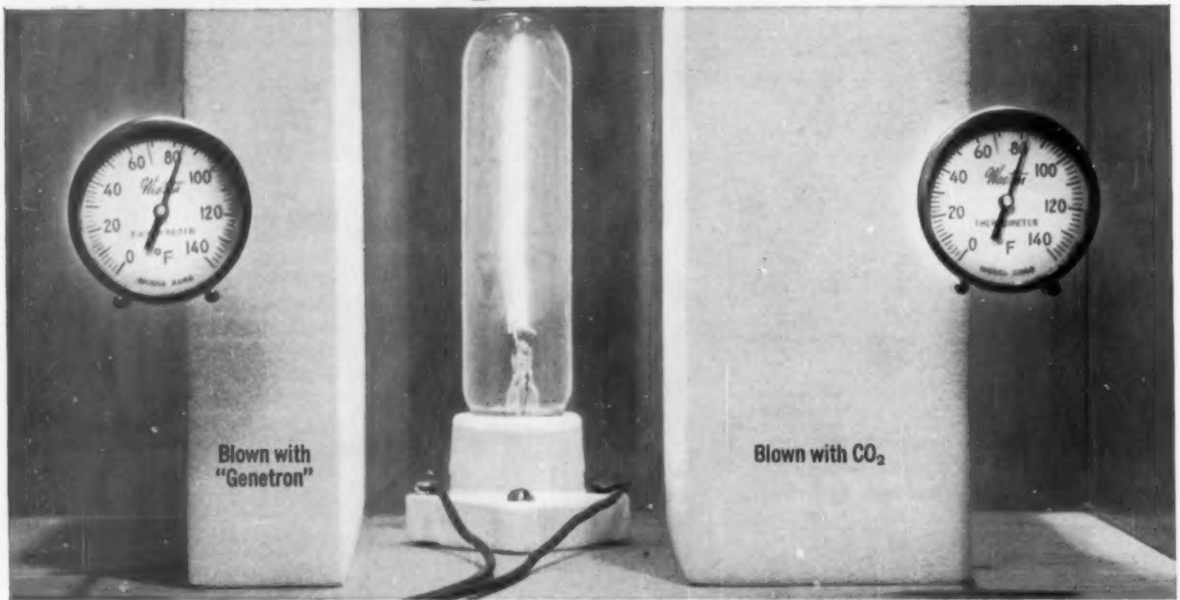

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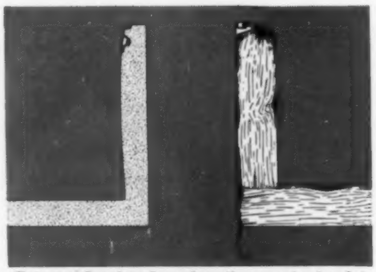

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Progress in reinforced polyesters

By G. Tolley†

Salient features of the present use and development of polyester resins in the United Kingdom are reviewed. Chemically resistant resins and faster curing systems are creating new applications and a re-appraisal of some existing methods of utilization. Organic reinforcements, particularly polyethylene terephthalate fiber, are arousing interest. Increasing use may be made of sisal and jute reinforcements in applications where high mechanical strength is not at a premium. There has been little development in the United Kingdom of mechanized processes for producing reinforced polyester components, although spray-up equipment is now being utilized on a limited scale. Tank- and pipe-welding processes are under active development and many proved applications have shown the merit of these products.

Reference is made to work on creep and fatigue properties, and it is held that such work must proceed alongside studies of the resin-glass bond, so that adhesion and adsorption properties are fully understood. Thermal and ultra-violet degradation of polyesters are viewed as a limiting factor in some applications. For the extension of future applications, particularly in engineering fields and building, much detailed work on the long-term properties of reinforced structures is seen to be necessary.

This article deals with matters of technological rather than scientific interest; it asks many questions and answers none; in short, it represents the point of view of the fabricator rather than that of the raw material producer. There will be no attempt in this paper to thoroughly review recent developments and applications. In the first place there would seem to be very little to add to Parkyn's 1959 survey (1)[1]. Secondly, a mere catalog showing progress would be of little interest to the reader. Rather it is the aim of this article to present some of the problems yet to be solved in order that reinforced polyesters should be capable of wider and more extensive use in fields as yet hardly touched.

It is desirable, however, to attempt to survey very briefly some of the salient features of the development of polyesters in the United Kingdom so that progress can be judged. While major improvements or developments have been few during the last year or so, one is more and more conscious, as reinforced plastics increase in scope and output, of refinements in techniques of production, processing, and control. A greater confidence in application is quite apparent. All this, however, stems rather more from experience in handling than from a better understanding of the nature and properties of reinforced polyesters. As far as the latter are concerned, there seems to be a very slow rate of progress, and essential data required for an extension of applications, or a thorough appraisal of existing uses, are lacking. Some areas in which such essential data are necessary will be referred to later. Let us first look at some very general matters concerning polyesters in the U. K.

Resins

The world shortage of maleic anhydride affected the situation in the U. K. only by retarding expansion rather than by any reduction in the total output. Of more interest than absolute production figures is the present pattern of distribution (Table I, below). It is interesting to note that the trend is increasingly towards the use of these materials in applications where durability as well as creep and fatigue properties are of essential concern.

Resins of improved chemical resistance and faster curing systems for hand lay-up have now become available. Epoxide-modified polyesters of good chemical resistance have been available for a number of years, but their high shrinkage on cure and their brittleness have limited their usefulness. The use

Table I: Distribution pattern of reinforced polyesters in the United Kingdom in 1960

Translucent roof lighting	30%
Boats and shipbuilding	15%
Aircraft	10%
Consumer goods	10%
Industrial use	7%
Land transport	20%
Other applications	8%

*Reg. U. S. Pat. Off.

†Research and Experimental Dept., Allied Ironfounders Ltd., Attingham, Nr. Shrewsbury, Shropshire, England.

Paper presented by title at the IUPAC Symposium of the 12th International Congress on Plastics in Torino, Italy, Sept. 28, 1960.

[1]Numbers in parentheses designate references at end of article, p. 196.

Table II: Effect of drying on final properties of laminate[a]

Glass mat[b]	Flexural strength: Untreated mat	Flexural strength: Dried mat and filler[c]
	p.s.i.	*p.s.i.*
I	38,700	45,700
II	30,600	34,200
III	29,800	28,000

[a]Laminates contained 30% by weight of quartz filler based on resin. [b]Chopped strand mats, 2 oz./sq. ft.: Mat I—E-glass, silane treated, polyester binder; Mat II—A-glass, silane treated, polyester binder; Mat III—A-glass, silane treated, polyester binder. [c]Glass mats dried 3 hr. at 40° C.; filler dried 3 hr. at 110° C.

Table III: Water absorption and flexural strengths of hessian laminates

Laminates	Filler	Thickness in.	Flexural strength: Initial	Flexural strength: Boiled 8 hr.	Water absorption[a]
			p.s.i.	*p.s.i.*	%
2 plies 1½ oz. glass	nil	0.038	21,500	13,500	0.45
1 ply 1½ oz. plus 2 plies hessian	nil	0.122	11,500	9,200	0.76
1 ply hessian/1 ply 1½ oz. glass/1 ply hessian	nil	0.08	10,300	8,500	1.40
2 plies hessian/1 ply 1½ oz. glass/2 plies hessian	nil	0.182	13,300	10,200	1.37
4 plies hessian	nil	0.17	9,400	8,100	1.44
4 plies hessian	50% quartz	0.17	10,150	8,200	1.35

[a]24 hr. immersion at 20° C.

now of phenols and phenyl-substituted dialkanols of moderate reactivity has resulted in modified polyesters having excellent resistance to caustic solutions.

Faster curing systems in which handleable components can be produced within minutes after lay-up are now being closely evaluated on some production lines. The advantages in securing greater turn-round of molds and economies in production are obvious. However, the very success of the fast-curing systems will force a detailed analysis of the costing of hand lay-up processes, many of which will not bear close examination.

Interest in the isophthalic resins is considerable, the all-round improvement in mechanical properties being of the greatest interest where engineering applications are envisaged. Such resins would seem to offer at least a partial solution to reverse impact troubles which have continually plagued applications in pipelines.

Increasing applications in transportation and building have stressed the importance of flame-retardant resins. It must be admitted that the use of HET acid and similar derivatives, and of self-extinguishing fillers, must represent only an early attempt at dealing with this problem. Incorporation of halogenated compounds must adversely affect weathering and aging and one would hope that more recent work with phosphorus compounds would lead to results of value.

Bounding sales of translucent roof lighting have focussed attention upon durability under atmospheric weathering conditions. Acrylic modified polyesters have undoubtedly proved their superiority here, in the absence of a 100% acrylic having the desired physical and mechanical properties. Sonneborn and Bastone's paper (2) summarizes the results of exposure tests which included acrylic-modified resins, and their results are encouraging.

It is now becoming increasingly apparent that while major improvements in resin quality and uniformity have been made over the years, there are many fundamental points concerning behavior on which ignorance is more obvious than knowledge. We know, as yet, little concerning the fate of inhibitors, and not a great deal concerning chain growth. Since mechanical properties of cured resins are dependent upon the peroxide catalyst used (3), further work leading to elucidation of the role of the catalyst is obviously necessary. Many points such as this, of apparent academic interest only, have been too long unexamined, and for the well-being of the industry as a whole should be looked at in detail.

Reinforcements and fillers

There is little to report concerning the use of glass as a reinforcement, although interest in organic reinforcements is increasing. The use of readily soluble polyester binders is now rapidly becoming standard practice, usually in association with E-glass, for most chopped strand mats. There is still, however, rather a wide spread in the properties of laminates using various types of chopped strand mat. Some binder systems in particular are very susceptible to water vapor under normal storage conditions, as Table II, above, shows. Obviously, under conditions where maximum strength is required, storage conditions for some mats are rather critical.

Polyethylene terephthalate (Terylene), nylon, and cellulosic fibers such as rayon, jute, and sisal have latterly been subjected to careful assessment. On a cost-per-unit-strength basis, it is certain that glass is very well placed by comparison with other reinforcements, but where lower strengths are acceptable, or lower water absorption necessary, then organic fibrous reinforcements may find a place. Terylene, of course, has its own role to fulfil in conferring chemical and abrasion resistance on laminates, when used as a surfacing tissue. The superior behavior of Terylene-surfaced laminates has been reported in detail (4). It is unfortunate, however, that no surfacing tissue gives as good a surface appearance as a gel-coat. While, therefore, increased abrasion and chemical resistance and improved impact strength can be obtained by using Terylene surfac-

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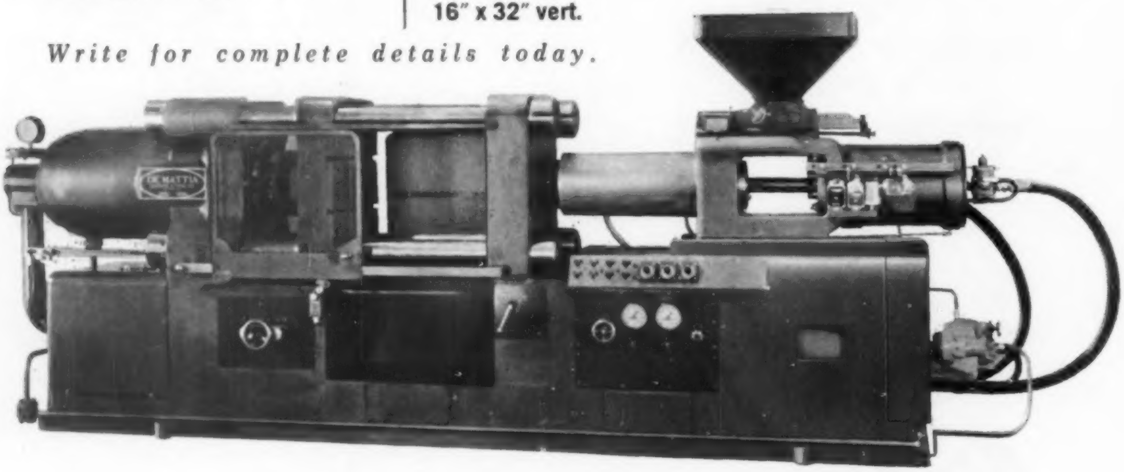

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ing tissue, there is no solution, as yet, to the problem of improving these properties while retaining the sparkle of a cold-cured gel-coat. There are still many applications in which appearance is important, and the surface tissue may detract from a high degree of finish.

The use of sisal as a reinforcement has received attention recently and chopped rovings have proved particularly efficaceous in dough molding compounds. Easily handled, light weight mats have not yet materialized, however, and the heavy yarns used in the coarsely-woven mats at present available are not suitable for hand lay-up, and are processed with difficulty in press moldings. Properties have been reported (5) for sisal in premixes, but the use of sisal mats as reinforcements has been less successful. It is doubtful, in fact, whether the tough Agave fiber will find extensive use in such form. There could, however, conceivably be an outlet for relatively low performance pipe using impregnated rovings helically wound. Cost would be low, and high water absorption may not be so troublesome as at first may be imagined.

The use of jute as a reinforcement in the form of hessian does not seem to have had the attention it deserves. Here is a cheap material capable of giving moderately good mechanical properties, and attractive finishes if these are sought. Water absorption tests show that the percentage decrease in properties is no greater with hessian reinforcements than with glass (Table III, p. 124).

As with glass, so with hessian, it is to be expected that treatment of the fiber could change the properties of the laminate. It might, however, be found that the strength of bond between polyester and cellulosic fiber is particularly high. Although it is unlikely that cellulosic reinforcements will be of value in laminates where high mechanical strength is at a premium, a more extensive knowledge of the fatigue and creep properties of laminates containing such reinforcements would be of value in throwing further light upon creep mechanisms.

Of fillers, there is little new that can be said. Flake glass and glass powder have come into prominence lately, but there is little commercial use made of either. The early use of fillers as extenders, thereby cheapening the product, has now almost disappeared, and fillers are now added to improve surface properties. The reduction in incidence of crazing obtained by the addition of almost any filler to a polyester is evidence enough of the strained condition of a cured resin. Some recent tests in these laboratories (Figs. 1 to 4, pp. 127-131) have, however, shown the occurence of a peculiar type of blistered attack upon filled polyesters, blisters being produced in spite of reduction in crazing. Such blisters were particularly apparent with quartz fillers. The effect of catalyst and accelerator concentration is well brought out here, since, in spite of a postcure at 100° C. for 1 hr., some samples were obviously undercured. Excess of accelerator increased water absorption in all cases.

Processes

Major developments and changes in the handling of polyester laminates have come about as a result of the introduction of pre-impregnated materials and of mechanical spray-up equipment, although neither of these has made a significant impact on the industry as a whole.

Polyester prepregs were introduced into the U. K. some three

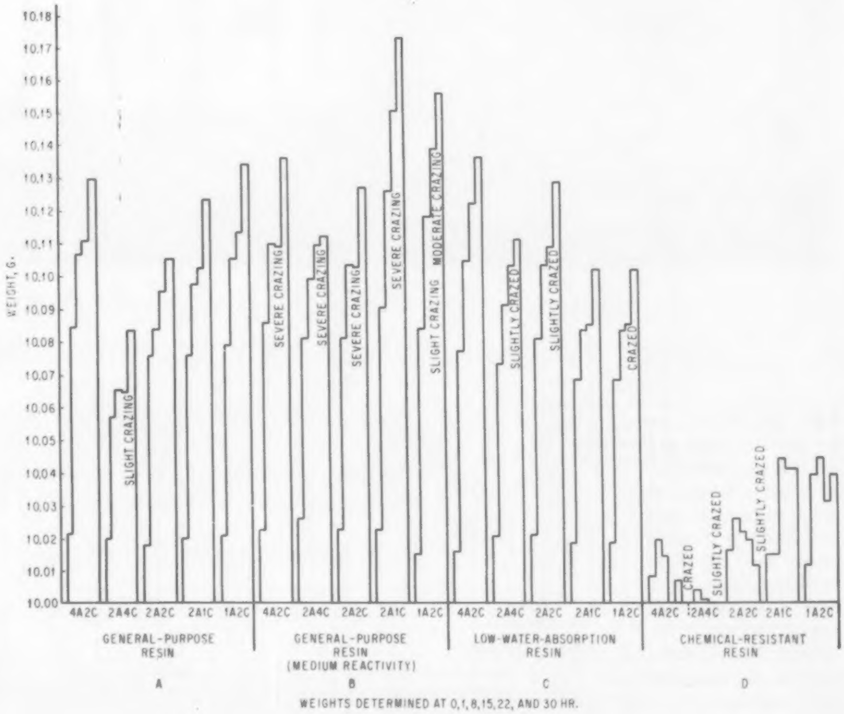


FIG. 1: Weight increases after various periods of boiling in distilled water for unfilled polyester resins with different proportions of catalyst and accelerator. A—Accelerator concentration (% cobalt naphthenate). C—Catalyst concentration (percent of methyl ethyl ketone peroxide).

years ago in a not very satisfactory form. Improvements in process control have resulted in reproducible materials, rather more easily handled than previously, but still too expensive for general application. In the aircraft or electrical industries where high strength and/or precise control of properties is essential, then prepregs can be used economically. In other fields, however, little headway has been made in extending applications. There could be no better illustration of the fact of reinforced plastics being an under-capitalized industry, than in the barely moderate success of prepregs.

On the development of spray-up processes, little need be said here, since progress in the U. K. has, in general, followed earlier work in other countries. Winding processes for piping, although under development for many years, have only recently become commercially significant, and confidence in the product still has to be built up. An interesting and valuable application of the helical winding process is Jaray's development of the method and its use in the production of large tanks (6). Although the method has been taken up to a very limited extent in the U. K., several firms on the continent are using the process. With this method, prestressing of structures can be accomplished, and a high degree of control exercised over resin and glass contents.

Creep and fatigue properties

Many of the more recent significant applications of polyesters demand, for their complete exploitation, a thorough understanding of the factors determining durability,

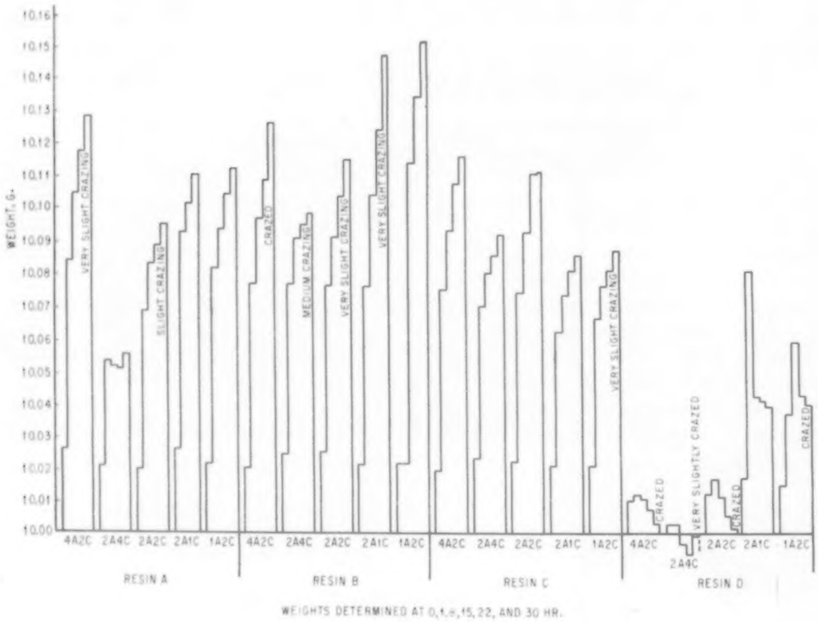


FIG. 2: Weight increases after various periods of boiling in 2% Tide solution for unfilled polyester resins made with different proportions of catalyst and accelerator.

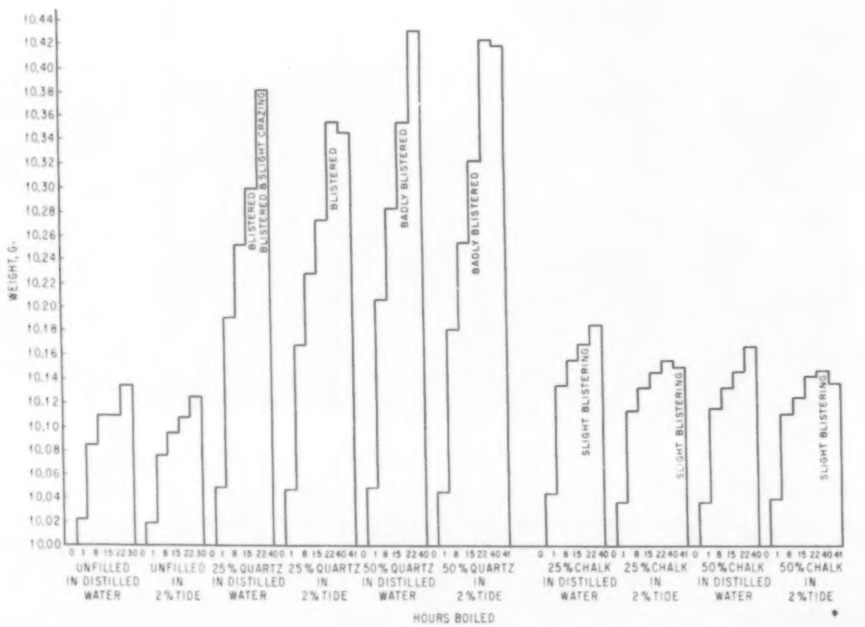
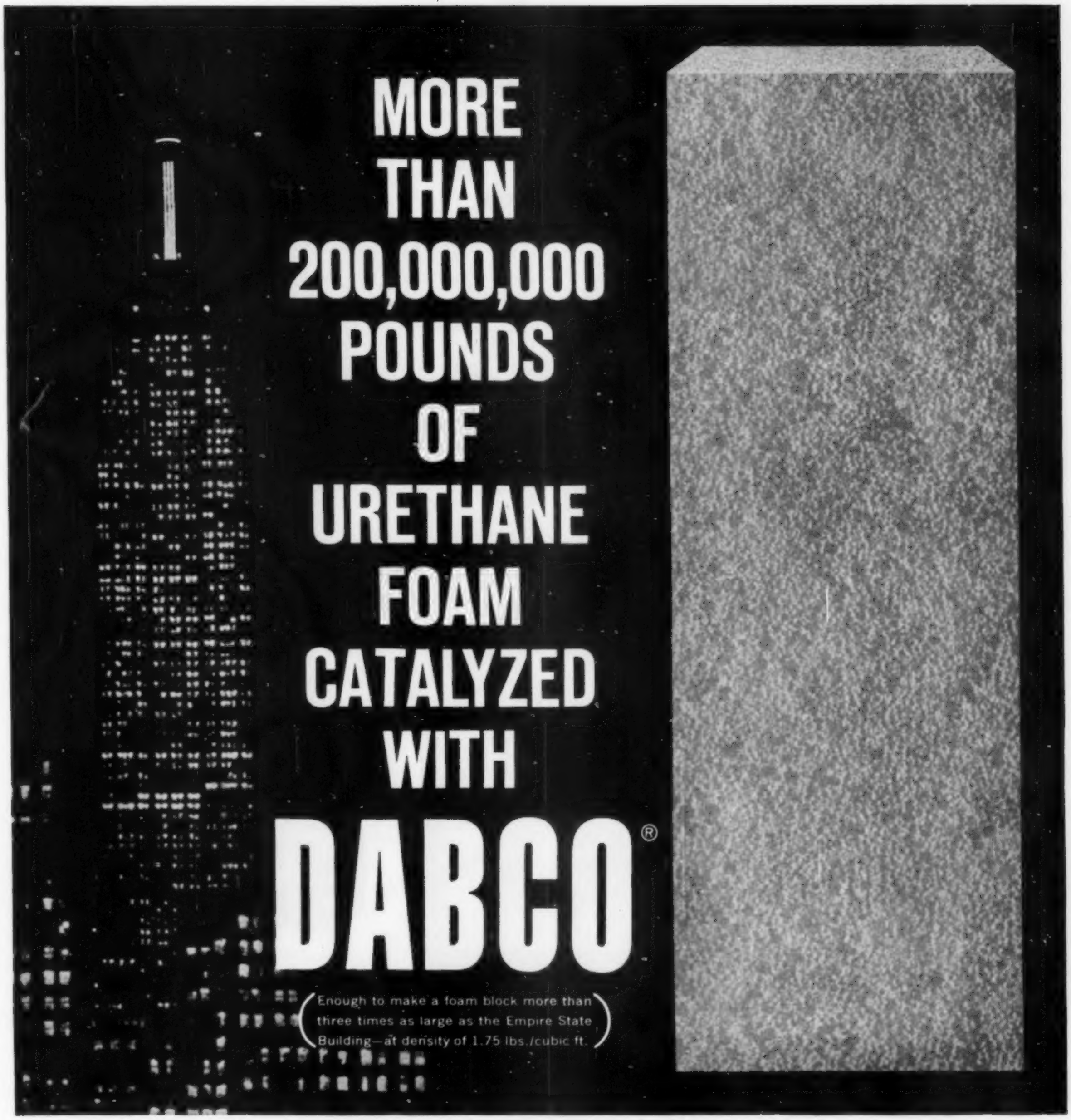


FIG. 3: Weight increases for filled and unfilled samples of polyester Resin B after various periods of boiling in distilled water and 2% Tide solution. Resin made with 4 ml. of cobalt naphthenate and 2 ml. of methyl ethyl ketone peroxide for each 100 g. of resin.



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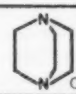

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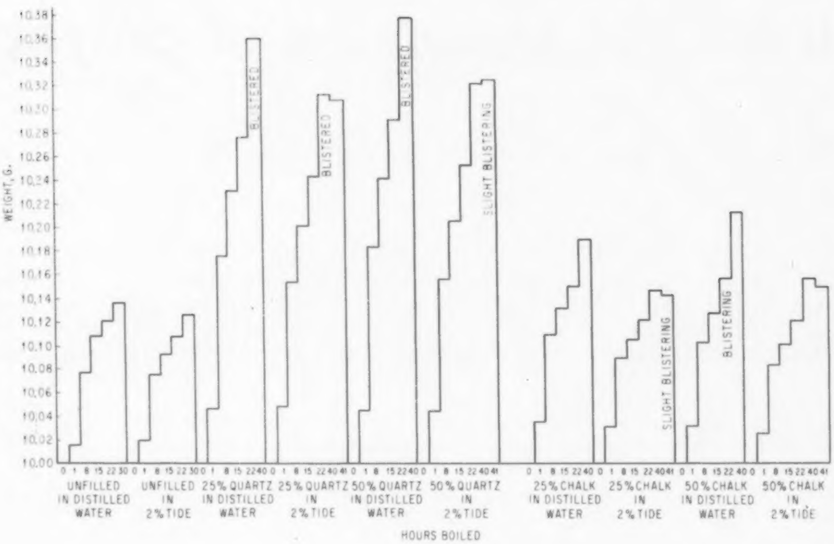


FIG. 4: Weight increases for filled and unfilled samples of polyester Resin C after various periods of boiling in distilled water and 2% Tide solution. Resin made with 4 ml. of cobalt naphthenate and 2 ml. of methyl ethyl ketone peroxide per 100 g. of resin.

and while aging and weathering of surface of a laminate is one important aspect of this problem, the most important factors are dependent upon the resin-glass bond as influenced by the coupling agent that is used.

Recent studies (7) of adsorption and adhesion by glass fibers point the way to a thorough understanding of the processes underlying creep behavior, although little information is available yet which may be applied with precision. Adsorption data that have been published are not readily comparable since glass substrates that were incompletely cleaned have been used. Degassing at 150° C., or treatment at a temperature below that necessary to cause charring of the size, can hardly be considered satisfactory in producing a desirable reference state. It is, however, obvious from these measurements that —OH groups are necessary for vinyl silanes and trichloroalkyl silanes to react with glass. It is also apparent that polyesters couple indirectly through styrene (or other crosslinking monomer) polymerizing at the surface of the glass, but the role of the vinyl groups in a vinyl silane is not clear, as far as the polymerization is concerned. An ionic mechanism for polymerization has, in fact, been suggested.

Because of the fact that satisfactory values for heats of adsorption of coupling agents or polyester complex are not available, and since insufficient is known of the role of adsorbed —OH, a great deal remains to be done to bring order into this field. Examination of the properties of, and interactions between, single fibers, preferably with freshly formed surfaces, and simple resin films would seem a good way of obtaining information of value. Latterly, of course, the trend towards mats that wet out more rapidly has obscured the need for a better understanding of the resin/coupling agent/glass bond, thereby delaying a fuller interpretation of the behavior of laminates.

In the absence of a thorough understanding of the resin-glass bond, it will be difficult to formulate a detailed mechanism of creep and fatigue behavior. The latter, however, are now being actively investigated in many centers, and data should soon be available to enable designers to work with confidence. It is apparent already that the Larson-Miller equation can be used to reliably estimate the creep-rupture stresses of reinforced polyesters (8). While the Larson-Miller correlation is useful as an aid to design, its very success in this application has obscured the lack of understanding of creep properties. The utility of an empirical equation is no substitute for detailed knowledge of mechanism. In standards that are used for polyvinyl chloride and polyethylene pipe, the Larson-Miller correlation has been used, and for a 50-yr. life a stress of 13 to 27% of the short-term tensile strength is allowed. The factor of safety allows for the occurrence of both ductile and brittle failure. For glass-reinforced polyester materials, from curves already published, it would seem that, for a similar life, 10% of the short-term value could be used. Here, however, extrapolation is less certain than with the thermoplastics. It is known that crazing affects fatigue peformance (9), and must also affect creep, and there may be alternative modes or mechanisms of failure depending upon the nature of surface attack upon the laminate.

Apart from the use of the Larson-Miller formula, it is known that the classic creep equation

$$\epsilon = \epsilon_0 (1 + t^n)$$

can be used on the basis of a 100-hr. test. Either method seems capable of yielding results of value to the designer.

Fatigue data that are at present available show extremely interesting possibilities for reinforced polyesters, with strength retentions being somewhat better than for some aluminum alloys. "Corrosion" fatigue properties are, as yet, relatively unknown, and problems related to reverse impact damage are far from being **(To page 192)**

Infra-red spectrum of polyethylene

By D. L. Wood* and J. P. Luongo*

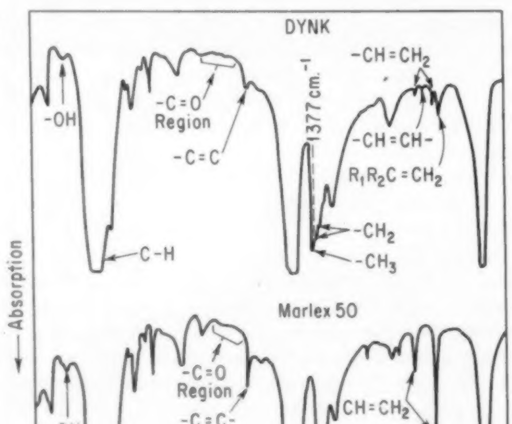
The advantage of being able to make measurements on the polymer rather than on model compounds makes infra-red spectrophotometry especially important for the understanding of the molecular structure of polymers. In the case of polyethylene, it has been possible to study several useful properties. 1) Crystallinity has been accurately measured, although the exact meaning of the values obtained in terms of the structure of the polymer is not clear, nor do the results of the several other methods for measuring crystallinity agree exactly with the infra-red results. 2) Branching of polyethylene can be determined reasonably well, both with regard to the number of side chains and also with regard to their structure. This requires rather sophisticated measurements with double-beam compensation techniques and a good linear polymer for a reference standard, but careful work can yield satisfying results. 3) Oxidation of polyethylene can be observed during the actual oxidation process. This has made it possible to obtain direct evidence bearing on the chemical reactions involved in the complicated sequence of events of the degradation process. Up until the present time, only qualitative studies of the formation of intermediates and the final end products have been made, and many more quantitative measurements still need to be made.

Polyethylene is one of the first polymers to have been intensively studied by infra-red techniques (1-10).[1] Since it is also one of the simplest polymers, it has played a forward role in the development of the use of infra-red spectrophotometry in polymer research. There are three broad fields of investigation for polyethylene using infra-red techniques, and these are also of interest for other polymers. They are: oxidative degradation, crystallinity, and molecular structure (branching).

The infra-red spectrum of polyethylene would be quite simple if the actual polymer was really just the ideal long hydrocarbon chain. The spectral features characteristic of the departures from ideality can be easily distinguished, however, partly by their relative intensities. Fig. 1, right, shows the spectrum of two kinds of commercial polyethylene in the condition resulting from normal manufacture. At the top is Bakelite[2] DYNK, a relatively highly branched polymer; the lower spectrum is that of Marlex[3] 50, representing a relatively unbranched polymer. The thickness of the specimens from which these spectra were recorded was chosen in order to demonstrate the characteristic structural differences between a nonlinear and a linear polyethylene. The very strong bands in the spectrum are due to CH vibrations. At 2800 cm.$^{-1}$ are found the stretching vibrations of various kinds. At longer wavelength or lower frequency are the deformation bands; the rocking vibration, which is so strongly affected by crystallinity, lies near 725 cm^{-1} and the various scissors, twisting, and wagging vibrations are in the center of the spectrum near 1400 cm.$^{-1}$. The deformation vibration of the CH_3 group is different from that of the CH_2 group, at 1378 cm.$^{-1}$, and more will be said about the estimation of branching using this fact. The bands arising from unsaturation in the molecule are found in the 1000 cm.$^{-1}$ region, and those due to the oxidation products, C = O and OH, are found near 1700 cm.$^{-1}$ and 3400 cm.$^{-1}$, respectively. The weak bands in the 2000 cm.$^{-1}$ region are due to overtones of the bands in the longer wavelength region, and will not be discussed in detail in this article.

Many of the infra-red absorption bands observed in the spectrum, especially in the region between 1700 cm.$^{-1}$ and 3400 cm.$^{-1}$ arise from vibrations of the molecule as

FIG. 1: Infra-red spectra of Marlex 50 and Bakelite DYNK.



*Bell Telephone Laboratories Inc., Murray Hill, N. J.
[1]Numbers in parentheses designate references at end of article, p. 208.
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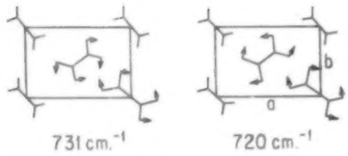

FIG. 2: End view of polyethylene unit cell, showing two possible combinations of the two molecules per unit cell (Reference 3).

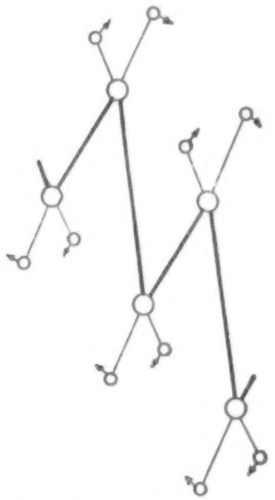

FIG. 3: CH_2 rocking vibration in polyethylene molecule (Reference 3).

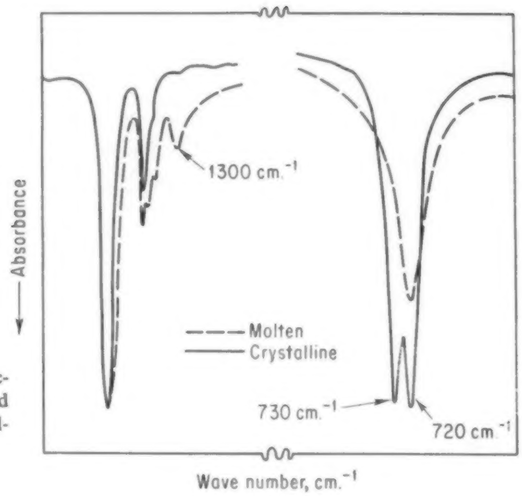

FIG. 4: Infra-red spectra of amorphous and crystalline polyethylene (Reference 14).

a whole, or of large segments of the molecule. It is not true that a C-C vibration, for instance, can occur without the involvement of many other C atoms nearby in the molecule. Assignments of bands in this region of the spectrum are, therefore, rather difficult and involve the analysis of the normal modes of vibration of the whole molecule, often an impractical task. A great deal of this kind of analysis has been accomplished for polymers in the past few years, mainly by Nielsen and Woolett (1) and Krimm, Liang, and Sutherland (3). It is fortunate that for polyethylene the bands that we will be discussing are all characteristic of particular vibrations of particular molecular groupings, such as CH stretching, C = O stretch, or CH_2 deformation, and have been identified as such, mainly from studies of model compounds.

Crystallinity

We will consider first the spectrum of pure polyethylene with no unsaturation and no oxidation, and discuss later the features characteristic of degradation and branching. One of the important characteristics of the material which affects greatly its fabrication and end use is the crystallinity (11). The influence of crystallinity on the mechanical properties of the polymer arises from the effect of order on the molecular level. This order permits very close approach of one molecule to another, over long lengths of the molecules, rather than just multiple crossings and entanglements. This permits more rigid polymers (12). The technical description of the crystalline portion of the polymer is given in terms of the unit cell. The unit cell is the smallest unit with which the whole crystal can be constructed with translations only. For polyethylene the unit cell contains two molecules (13). These molecules are extended, planar ribbons, and they are packed together, not like ribbons piled together in a bundle, but each one with its plane almost per-

Table I: Weight percentage of amorphous material for polyethylenes as measured by various methods (Reference 2)

	Amorphous content		
Sample	*By infra-red*	*By density*	*By X-ray*
	%	%	%
Bakelite DYNH	53 ± 3	46 ± 1	30.2 ± 0.3
Bakelite DYNJ	52 ± 1	46 ± 1	30.9 ± 0.8
Bakelite DYNK	49 ± 1	46 ± 1	29.1 ± 0.4
Du Pont Alathon	58 ± 1	46 ± 1	—
ICI #2	54 ± 1	46 ± 1	32.2 ± 0.8
Polyethylene I	29 ± 2	19 ± 1	9.7 ± 0.3

Table II: Calibration data for ethyl branches (Reference 29)

Hydropol resins				
Code	*Unsaturation*	*Total methyls (CH_3/1000 C from K_{1378})*	*K_{770} (O.D./cm. at 770 cm.$^{-1}$)*	*Ratio: (CH_3/1000C)/K_{770}*
	%			
L.S.	2 to 7	44	9.0	4.9
T.P.	8	41	8.1	5.1
U	18	37	6.7	5.5

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pendicular to the next (3). The molecules can do this because the contact cross section of the molecule is almost round like a rope rather than a ribbon. Figure 2, p. 134, shows the end view of the unit cell of the polymer. The close approach of the molecules in this close packing allows strong forces to act down the whole length of the molecule, and thus bind the polymer into a stiffer, stronger material. The effect of crystallinity on the spectrum can be described in the following way.

Consider the molecular vibration shown in Fig. 3, p. 134. This is the CH_2 rocking vibration of rather low frequency (3). The hydrogen atoms move together in a direction perpendicular to the molecular chain. Now when the isolated molecule is put into the unit cell, there are two ways the phases of the two molecules per unit cell can combine, as shown in Fig. 2. In the higher frequency mode on the left in Fig. 2, the hydrogen atoms tend to collide during the oscillation, whereas in the lower frequency mode on the right the hydrogen atoms tend to go in the same direction, and the frequency is in essence more nearly that of the free molecule.

The result of having two molecules in the unit cell, therefore, is to double the number of frequencies of the free molecule. This is a general result of crystal spectra for small molecules also.

The observed infra-red spectrum is shown in Fig. 4 (14), p. 134. The conspicuous difference between the melt spectrum, which arises from the amorphous phase, and the crystalline spectrum is the doubling of the band near 720 cm.$^{-1}$, which is due to the vibration illustrated in Fig. 3. There is also an effect on the other CH vibrations, but the interaction of the two molecules is less and the splitting of the bands is smaller. The quantitative determination of crystallinity is, therefore, a matter of measuring the intensity of the higher frequency band of this pair relative to some other reference band. Tobin and Carrano (2) have used the intensity of the band at 730 cm.$^{-1}$ to determine the crystalline content and the band at 1300 cm.$^{-1}$ to determine the amorphous content. Together with the relation that the amorphous and crystalline fractions must add up to unity the analysis can be made. Use of the band at 720 cm.$^{-1}$ to determine amorphous content is difficult because, as can be seen from Fig. 4, there is also a contribution from the crystalline por-

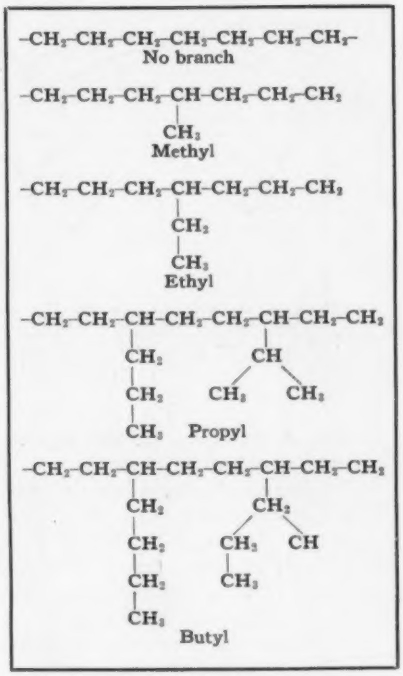

FIG. 5: Types of branching in commercial polyethylenes.

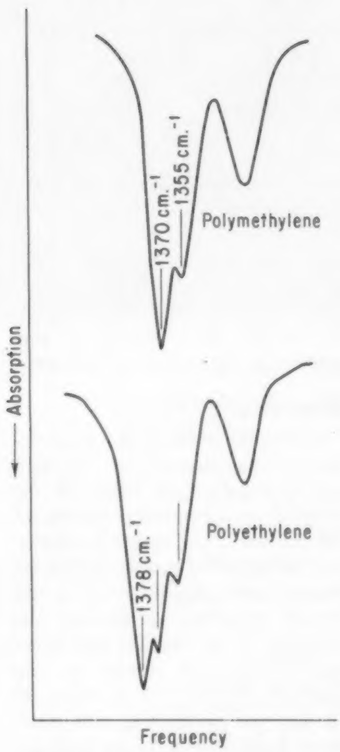

FIG. 6: Infra-red spectra of polymethylene and PE in the 1370 cm.$^{-1}$ region.

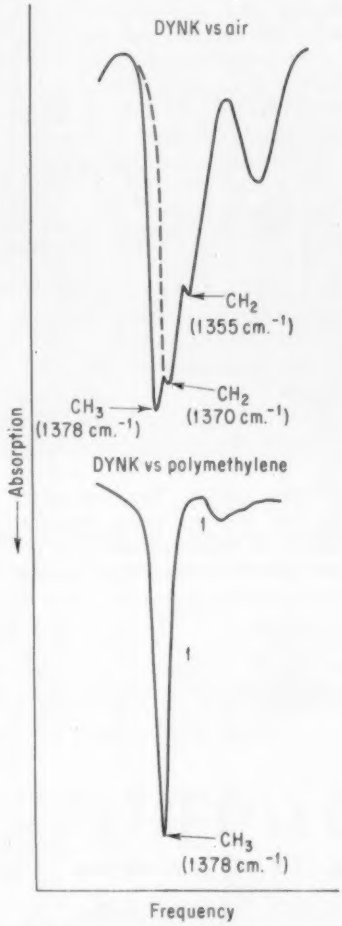

FIG. 7: Determination of methyl group content in PE.

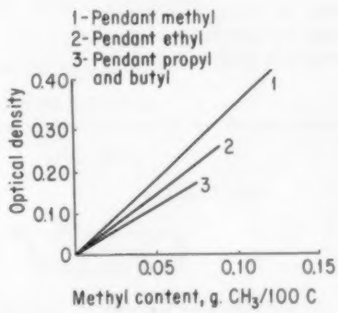

FIG. 8: Optical density of the 1375 cm.$^{-1}$ methyl band vs. the methyl content (Reference 41).

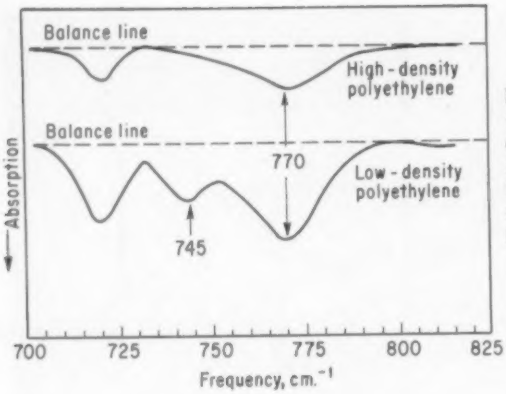

FIG. 9: Infra-red spectra of low- and high-density polyethylenes from 700 to 800 cm.$^{-1}$ by the double-beam compensation method (Reference 29).

tion. A correction for this aspect must be applied.

There are also three other methods of determining the crystallinity of polyethylene, using density, X-ray diffraction, and heat of fusion. None of these methods give an absolute value of crystallinity.

Perhaps the simplest method is that of density determination (15). This depends on the fact that the

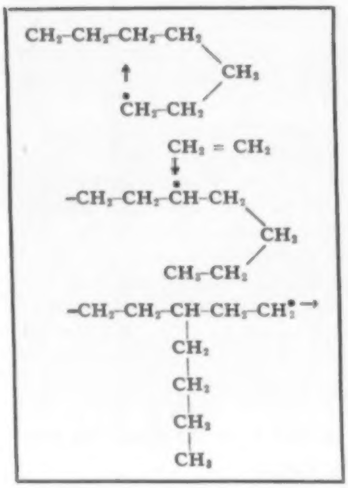

FIG. 10: Schematic mechanism for formation of butyl groups in polyethylene.

molecules are more closely packed in the crystal than in the amorphous material, giving a higher density for the crystalline portion. The purely crystalline polymer, by extrapolation of data on polymers of varying crystallinity, has a density of 1.00 g./cc., while the purely amorphous has a density of 0.8 g./cc. A linear relation between the density and crystallinity prevails between these two extremes (14).

The second method using X-ray diffraction depends on the fact that crystalline material diffracts the X-rays in sharply-defined directions whereas the amorphous material scatters more diffusely (13, 16-19). This is because there is a definite phase relation between the rays scattered from successive atoms in the crystal but no definite relation in the amorphous phase due to the disorder. The ratio of the scattered intensity from the crystalline portion to that from the amorphous portion will give the crystallinity.

The third method depends on the heat of fusion of the crystalline polymer (20-21). The anomaly in the heat capacity versus temperature curve which accompanies the melting of the crystalline portion can be used to determine a heat of fusion for a given sample. The ratio of this quantity to the similar quantity for a crystalline sample or a crystalline hydrocarbon gives a value for the crystallinity.

Tobin and Carrano (2) have compared the results for the infra-red, X-ray, and density methods (Table I, p. 134) and find that general agreement is obtained between the infra-red and density measurements for several different samples, but they also find that the X-ray method gives much higher values for the crystalline fraction. The range of crystallinities investigated is not very wide, but the significant fact is that the methods give consistently different results. We believe that the origin of these differences lies in the fact that the word "crystalline" has a different definition for each of the methods. Or, putting it another way, material that one method sees as crystalline, the other method sees as amorphous. The X-ray method depends on rather short range order, the infra-red method depends on somewhat longer range order, and the density method involves the whole sample and will be influenced by molecular weight and branching and the defects introduced by them.

The crystallinity of a polymer is very much dependent on the thermal history of a given sample. In truth, the crystallinity of a given polymer is never measured, but rather the crystallinity of a particular sample of the polymer is measured. Because of this fact and the ambiguity in definition of the term, it is only possible, at the present time, to give a value for crystallinity of PE which should be considered as "infra-red crystallinity."

Branching

Branching is one of the most important characteristics of polyethylene, because of its effect on the physical and chemical properties of the polymer. The molecule seldom has the idealized straight hydrocarbon structure, and the molding and flexure properties are strongly dependent on the number and structure of the side groups on the chain (9, 10, 22, 32). It can easily be seen that branching will affect crystallinity (13) since the branches will get in the way of the close approach of molecules in the unit cell.

Some of the various types of

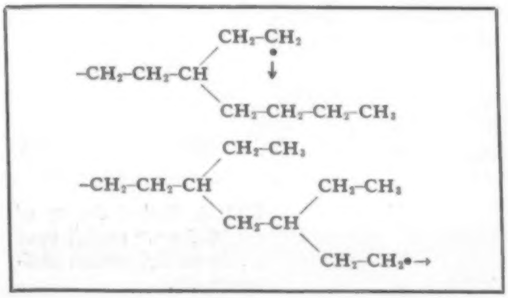

FIG. 11: Schematic mechanism for formation of ethyl groups in polyethylene.

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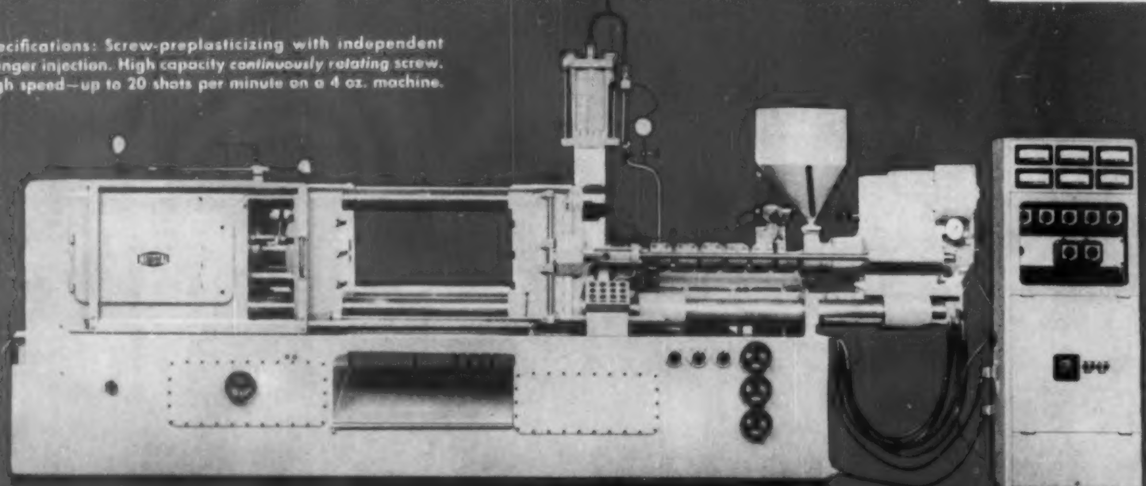

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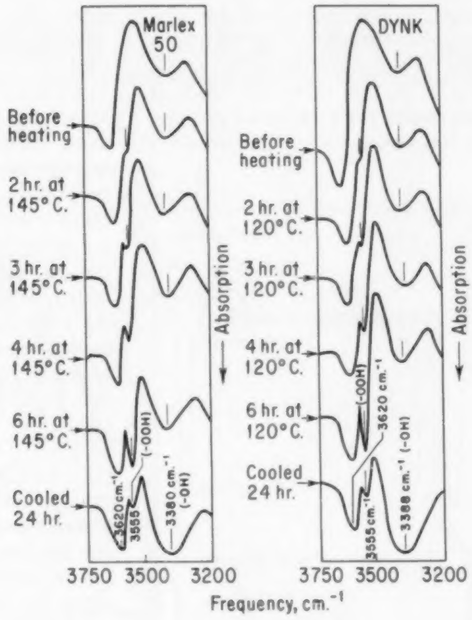

FIG. 12: The —OH stretching region of polyethylene during and after accelerated oxidation.

$$1)\quad RH \xrightarrow{\text{Activated}} R^{\bullet} + H^{+}$$

$$2)\quad R^{\bullet} + O_2 \rightarrow ROO^{\bullet}$$
$$3)\quad ROO^{\bullet} + RH \rightarrow ROOH + R^{\bullet}$$
$$4)\quad ROOH \rightarrow RO^{\bullet} + OH^{\bullet}$$

$$5)\quad ROO^{\bullet} + HA \rightarrow ROOH + A^{\bullet}$$
$$6)\quad R^{\bullet} + A^{\bullet} \rightarrow RA$$

FIG. 13: Proposed reaction mechanism for oxidation of polyethylene.

branching that occur in commercially important polyethylenes are shown in Fig. 5, p. 137. At the top is the ideal molecule. Next is the methyl branch with one carbon atom. Successively are the ethyl, propyl and butyl side chains with two, three and four carbon atoms.

The earliest attempt at determining the branching by infra-red spectroscopy involved the measurement of the number of methyl groups per 1000 C atoms (5b, 23-25). Unbranched polymers would have only two CH_3 groups per molecule, while each branch would add another. In the infra-red, as already has been mentioned, there is a band due to the CH_3 group which is more or less separate from the rest of the CH vibrations. This band is at 1375 cm.$^{-1}$ or 7.26μ, and is shown in Fig. 6, p. 137. At the top is the spectrum of polymethylene, which has essentially no CH_3 groups for high molecular weights. Below is the spectrum of a commercial polyethylene. It is clear from the spectra shown in Fig. 6 that there is considerable overlapping between the CH_3 band and other CH bands. A correction must be made for this interference; this was difficult until the advent of ratio spectra (26, 27) whereby in a double beam spectrophotometer the ratio of absorption of two samples can be measured. If one of these samples is polymethylene and the other the branched polymer, the CH absorption common to both will be compensated out and only the CH_3 absorption will be observed (28, 29). The ratio spectrum of polymethylene and DYNK is shown at the bottom in Fig. 7, p. 137. The spectrum uncompensated is shown at the top. Intensity at 1375 cm.$^{-1}$ in the compensated spectrum gives a measure of the CH_3 content.

Hughes and Martin (30) have found, however, that the simple measurement of the CH_3 band intensity is not enough to determine accurately the CH_3 content and, of course, this alone could not tell the type of branch present. The reason for the inadequacy of the measurement is that the absorption coefficient for the CH_3 band depends on the environment of the CH_3 group even though the frequency is exactly the same. This fact is shown in Fig. 8, p. 137, where the optical density versus methyl content, expressed here as grams $CH_3/100$ carbon atoms, is plotted for three types of side chain. Since the slopes are different for the three types of branch, it is necessary to know the branch type distribution before the total CH_3 content can be determined. This difficulty has been overcome recently by Willbourn (29), following an observation made by

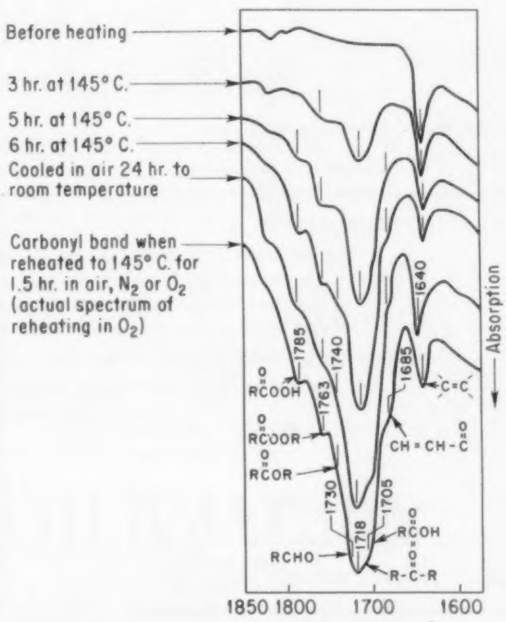

FIG. 14: Carbonyl stretching region of Marlex 50 during and after heat oxidation (in air) at 145° C.

Bryant and Voter (31) some years ago. These workers found that there are weak CH vibrations at long wavelengths near the CH_2 rocking bands at 720 cm.$^{-1}$. The identification of these bands with ethyl and butyl side chains has now made it possible to investigate the side chain distribution in detail. Fig. 9, p. 138, shows the bands in this region for a branched polymer as run against an unbranched polymer. The ethyl side chain frequency is at 770 cm.$^{-1}$; the band at 745 cm.$^{-1}$ is due to butyl branches. For quantitative estimates the ethyl branch concentration was calibrated using hydropol polymers having known ethyl branch concentrations. Some of the calibration data, taken from Willbourn's paper (29) are given in Table II, p. 134. In this case there was only one kind of methyl group and the intensity of the 1378 cm^{-1} band could be used to determine the number of branches. The coefficient for the 770 cm.$^{-1}$ band was then calculated from the quotient of the total methyl and the absorbance for the 770 cm.$^{-1}$ band, and gives a value of about 5.1 optical density/branch/1000 C atoms as shown in the last column in terms of ethyl groups per 1000 C atoms. The precision of the method is indicated by the variation of the values in this column.

The butyl side chain coefficient was determined from a set of polymethylenes polymerized with just butyl side groups. These were made just for the purpose by the I.C.I. group by reacting diazomethane with the appropriate diazoalkane and trimethyl borate (29). The corresponding deutero compounds were also made in such a way that only the side chains were deuterated. The number of side chains

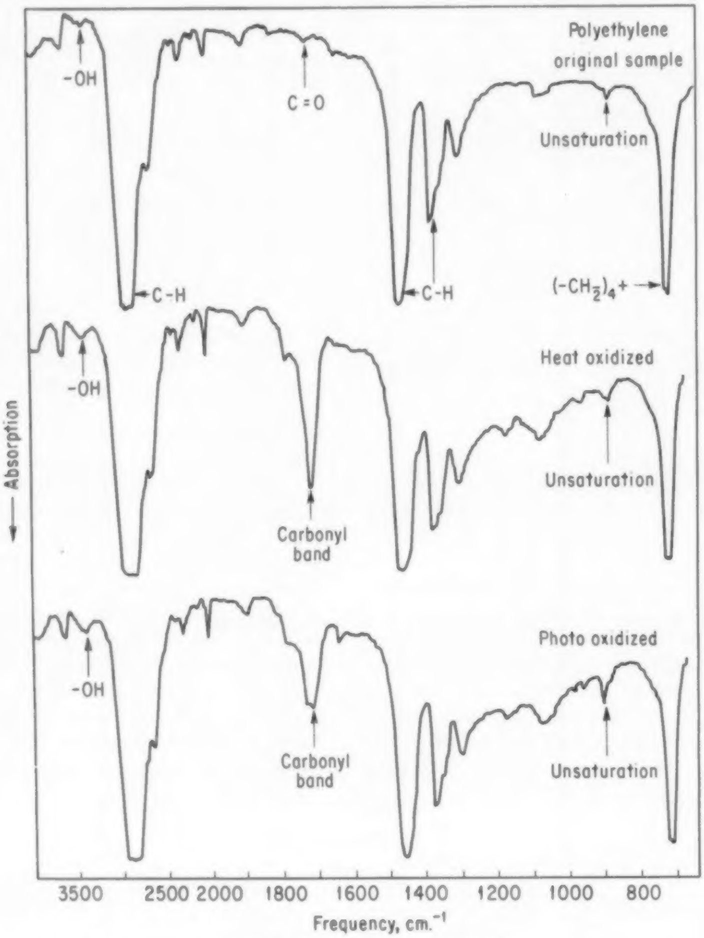

FIG. 15: Infra-red spectra of oxidized polyethylene.

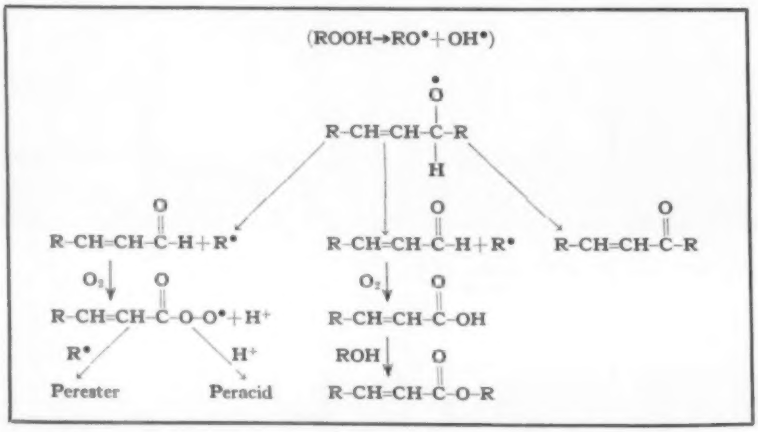

FIG. 16: Mechanisms of formation of oxidation products in polyethylene.

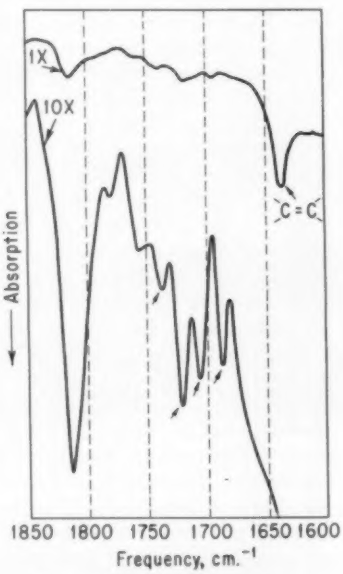

FIG. 17: Infra-red spectra in C-O region of mildly oxidized polyethylene.

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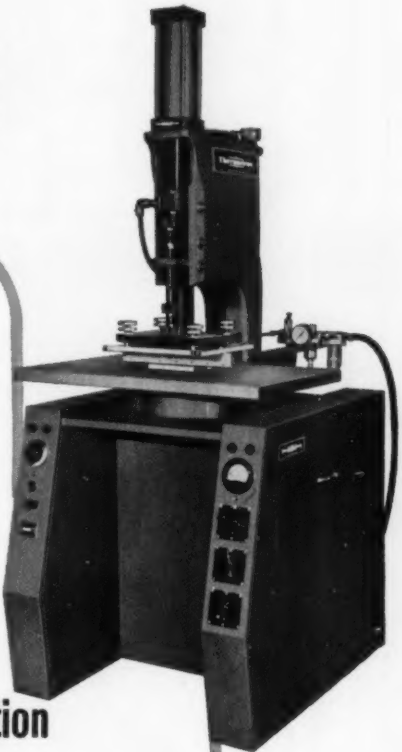

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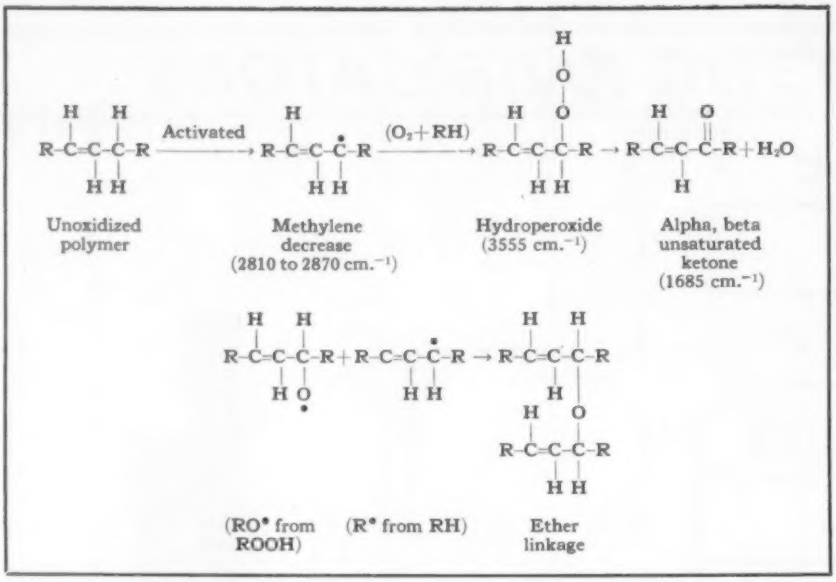


FIG 18: Proposed mechanisms for formation of alpha-beta unsaturated ketone groups and ether linkages during oxidation of polyethylene.

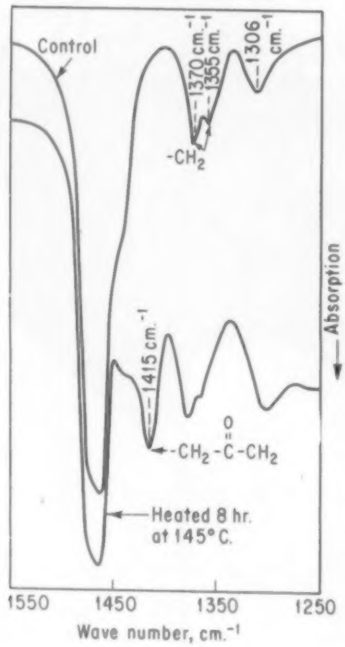
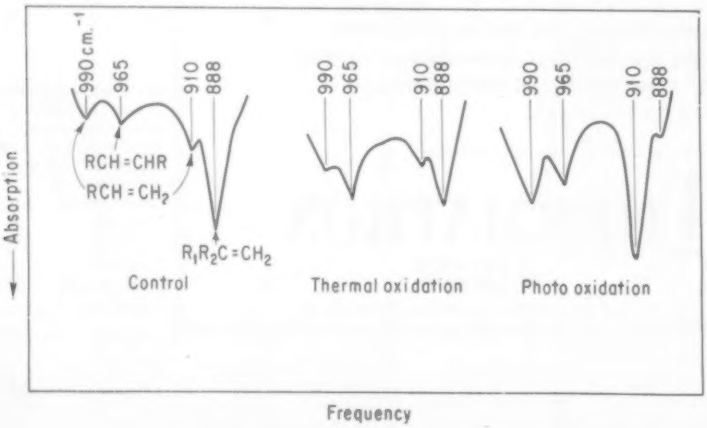


FIG. 19: Effect of heat oxidation on Marlex 50 in the C-H deformation region (1550 to 1250 cm.$^{-1}$).

FIG. 20: Effect of thermal and photolytic oxidation on unsaturated molecular groups in polyethylene.

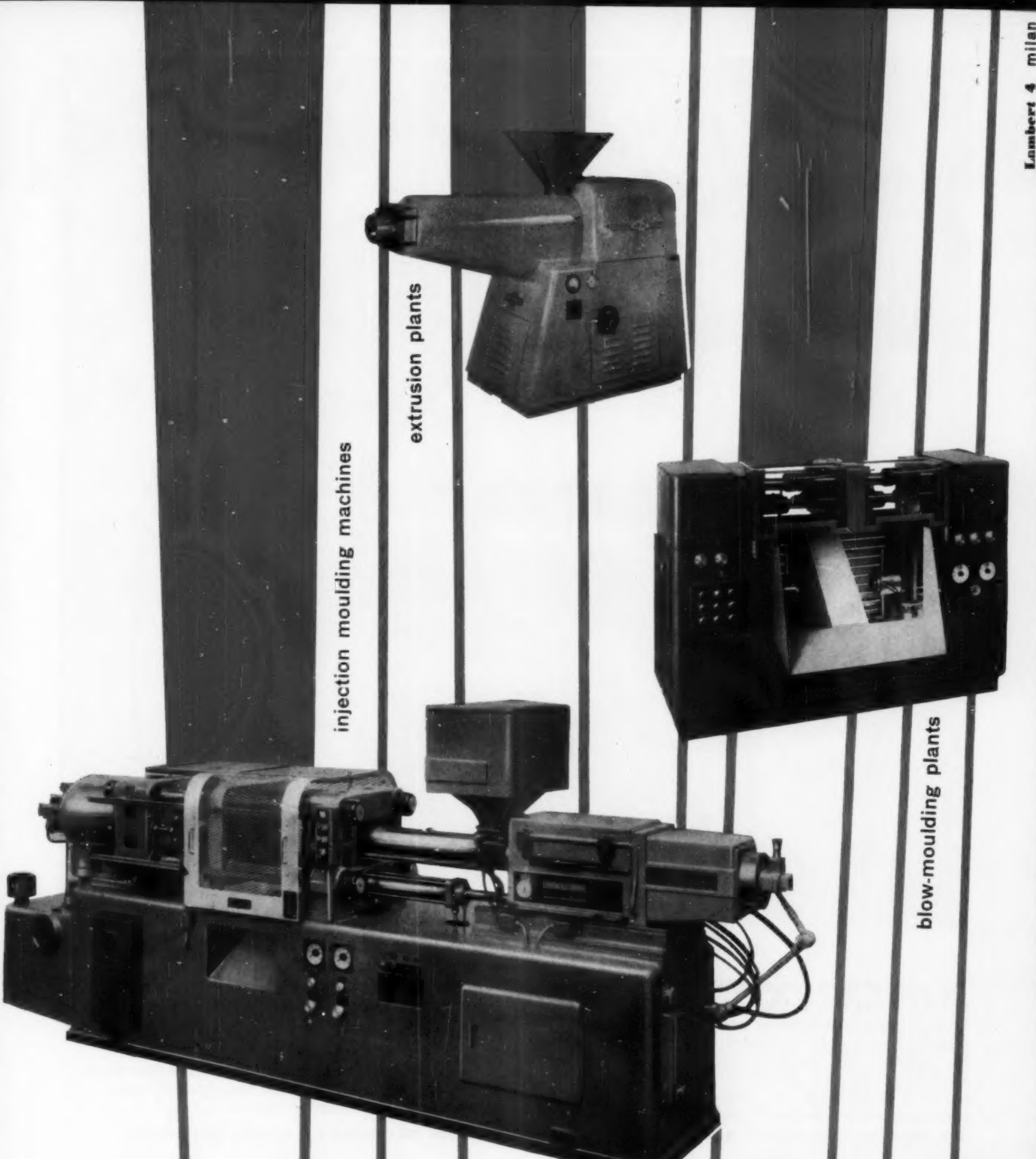


could then be determined by analyzing the deuterium content of the polymer. The intensity of the 745 cm.$^{-1}$ band was then used directly to calculate the coefficient for the butyl branch concentration.

The interesting part of the infra-red results on polyethylene is that no branches other than ethyl and butyl were found to be present in appreciable concentration. This result was also confirmed by a second method of determination of the branching, which involves the fragmentation of the polymer by high energy electrons and mass spectrometric analysis of the degradation products. There seemed, in general, to be a ratio of ethyl to butyl branches of 2:1 according to Willbourn (29), although recently, others have found different ratios (33). This 2:1 ratio can be accounted for by a sort of backbiting mechanism (11) which is shown schematically in the formula that is given in Fig. 10, p. 138.

Suppose that a long chain, in the process of polymerization, has at its end an active radical to which a new ethylene molecule would add to lengthen the chain. Suppose, however, the chain folds back before this happens and the active radical comes near the rest of the chain, as in the top line of Fig. 10. The smallest distance of approach permitted sterically is the fifth atom from the end. If the approach is near enough, there is a finite probability that the active radical will transfer to the fifth carbon atom and the polymerization will continue from this site as in the second line of Fig. 10. When this happens, the string of carbon atoms that formerly formed the end of the chain will now become a side group or a branch as in the third line of Fig. 10. There will be four carbon atoms in the branch, and this will be a butyl group.

A similar mechanism may be proposed for the formation of the ethyl groups in the normal process of polymerization. If, in the second step outlined above for the formation of butyl groups, we consider the stage where an ethylene molecule has just attached **(To page 198)**



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The result is closer tolerance extrusions at greatly increased outputs.

Egan Extruders with the new Air Cooled Willert System are available in sizes from 2" through 12", with L/D ratios of 20:1, 24:1, 32:1.

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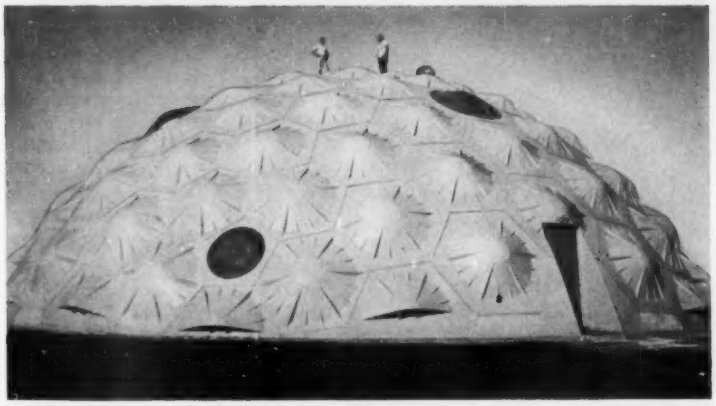
NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

Machined microminiature epoxy parts

Miniature and microminiature bobbins, coil forms, and encapsulating cups for the electronics industry are being produced with extreme accuracy and high economy by machining them from cast epoxy rod stock, according to Omega Precision Inc., Azusa, Calif. Parts as small as 1/32 in. OD and 1/32 in. long, with wall thicknesses of 0.004 in., are being turned out in quantity lots by machining to extremely close tolerances. Standard military and microminiature sizes are stocked, and a wide range of special sizes can be made to specifications.

According to Omega, which obtains its rod stock from Hysol of California, a Division of the Hysol Corp., Olean, New York, the cast epoxy material machines freely and the machined parts can be sold at half the price of machined TFE parts of similar size; machined epoxy parts do not cold-flow, which contributes to maintenance of close tolerances; parts 1/8 in. in diameter or smaller are cheaper to machine than to mold because of the high speed of machining and low tooling costs; and such parts can be machined fully automatically, including loading and unloading. In addition, rod stock of different colors, used to aid identification of different parts, can be interchanged in machining without changing the set-up.



RP DOME CAN BE PUT UP IN 24 HOURS

An 80-ft. diam., geodesic dome, built of interlocking panels of glass-fiber reinforced plastic, weighing only 10,500 lb., can be airlifted to any spot in the world and set up in less than 24 hr. to provide shelter for personnel and equipment.

The dome panels, produced by Tool Research & Engineering Corp., Beverly Hills, Calif., consist of hexagonal and pentagonal shapes which are flanged to interlock without special fastening. The dome is 28 ft. high, encloses 80,000 cu. ft. of space, and requires no specially-built foundation. According to the manufacturer, a dome will withstand winds of over 100 m.p.h. and it will also support heavy loads of snow.

The panels are made by sprayup of continuous glass fiber filaments and polyester resin. Polyurethane foam is gun-sprayed into each panel to provide insulation against wide variations in temperature. Suggested applications are for missile site structures, portable hospitals, classrooms, and silo covers.

Integral hinge for lens case

Astute designers and manufacturers are quick to seize upon new developments in plastics in order to create new product concepts or effect product improvements.

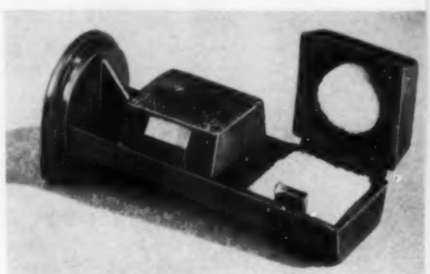
A case in point is The Opticase Co., Newark, N. J., which, in cooperation with industrial designer Irven Gershen, Maplewood, N. J., selected polypropylene as the material for the storage case for contact lenses which it is selling under the tradename Contacase. It retails for $4.00.

The case, measuring 1 7/8 in. long, incorporates two compartments, one for the left and the other for the right lens. Each compartment has its integral cover and its own lens cushion of die-cut vinyl foam. Polypropylene offered two significant features to the case, namely:

1. It provided a crisp feel to the unit, which made it pleasant to the touch.

2. It contributed an integral hinge, which made it possible to produce the entire basic unit in one single operation. Closure is achieved by snapping the cover over a molded-in projection at the front of the case. The hinge, like all polypropylene hinges, has practically infinite flex life.

The case is injection molded by Pyro Plastics Corp., Union, N. J., in a two-cavity mold from material supplied by Hercules Powder Co. Cost of the mold was $3200. The entire molding operation is fully automatic —which is why two cavities were sufficient for the job.



(More on next page)

High-impact acrylic nutcracker

High-impact acrylic, chosen for its strength and attractiveness, is used in molding seven components of a screw-operated nutcracker recently introduced by Teague Mfg. Co., Teague, Tex. The aluminum screw and cracking heads are the only non-plastic parts.

The molder, Intercontinental Plastics Mfg. Co., Dallas, Texas, estimates that it would cost nearly 50% more to produce the nutcracker in die-cast metal. Further advantages of virtually all-acrylic construction include light weight (total plastics weight is 10 oz.), resistance to staining, freedom from unpleasant odor, durability, dimensional stability, and ease of molding.

Acrylic parts are molded in one 7-cavity mold on a 12-16 oz. Reed-Prentice machine. Molding material is supplied by Rohm & Haas.

The nutcracker retails for $5.95, and is designed for shelling pecans, walnuts, hazel nuts, and Brazil nuts.

Polypropylene strainers

The thermal and chemical advantages of polypropylene are being put to use in a new series of pipe-line strainers produced by Vanton Pump & Equipment Corp., Hillside, N. J. The company has had a fairly long and successful history in the use of plastics for corrosion-resistant application in its pump models; this latest development complements a line of vinyl strainers it has been offering for the chemical and pharmaceutical processing industries.

The function of the strainers is to trap particles which would be injurious to internal moving parts or process equipment. Because of polypropylene's properties, the new strainers can be used at temperatures up to about 200° F. (appreciably higher than is possible with vinyl); will handle most weak acids and alkalies as well as some very corrosive acids; and their light weight permits installation directly upon the most delicate equipment. The strainers are injection molded in sizes ranging from ½ to 2 in. in diameter and come with molded-in thread or socket weld end. Prices are 10 to 15% higher than similar vinyl strainers. Prices go from about $16 for the ½-in. size to $45 for the 2-in. variety.

POLYPROPYLENE STRAINERS are injection molded for use in high-temperature or corrosive-fluids systems to screen out impurities.

Thermoformed ABS housing

An ABS (acrylonitrile-butadiene-styrene) sheet contributes toughness, mar resistance, light weight, and ease of maintenance to the vacuum-formed housing of the Auto Tutor Mark II, a pushbutton teaching machine marketed by Western Design & Electronics Div., U. S. Industries Inc., Santa Barbara, Calif.

The teaching device, designed by the firm of Channing Wallace Gilson, Los Angeles, Calif., displays a page-size image of information and questions on a lens screen by means of a 35-mm. projector. The student answers the question by pushing one of nine buttons, and if the answer chosen is correct, the machine moves on to new material. If the answer is wrong, the machine explains the error, and the student selects another answer. If it is again incorrect, the machine automatically goes back through an earlier instruction sequence, leading up to the material missed by the student.

The one-piece ABS housing is vacuum formed by Engineering Plastics Co., Pasadena, Calif., which uses custom-built equipment. Originally, the housing was to have been produced in welded metal sheet, but estimated tooling costs with this method were about twice as much per part as tooling costs for thermoformed sheet construction.

The part has a 14-in. draw, and is formed in a 2-min. cycle. Part weight is less than 2 lb., out of a total machine weight of 43 pounds. The ABS sheet, 20 by 80 in. and $\frac{3}{32}$-in. thick, is supplied by U. S. Rubber Co., Royalite Div., Chicago, Ill.

Transparent formfitting insulation

Insulating sleeving which is transparent and which shrinks to a smaller predetermined diameter when heated has recently been announced by Rayclad Tubes Inc., Redwood City, Calif. Furnished in modified polytetrafluoroethylene for high-temperature applications or in irradiated polyethylene based material for lower temperature uses, the sleevings are known as Thermofit TFE and Thermofit RF, respectively. Type TFE has an operating range of −100 to +500° F., with short-time exposure to 725° for 4 hr.; type RF from −67 to +275° F., with time exposure to 572° for 1 hour.

After the sleeving is originally produced in a given diameter, it is expanded to a predetermined degree: when reheated, "plastic memory" causes the tubing to shrink to its original size. The sleevings are offered in a wide range of expanded diameters and with shrinkages of from 30 to 90% in standard sizes; on special order, up to 400% is possible.

Rayclad Thermofit sleevings are reported to conform readily to complex contours, giving skin-tight encapsulation quickly and easily. Because they are transparent, they are reported to be excellent for use in difficult environments where part numbers must be visible or repeated inspection is desirable.

This transparency has another function: aiding in regulating cure time and temperatures. When the enlarged sleevings are applied to the part to be insulated they are not transparent. They become transparent only when heat shrunk to the proper degree, signalling the proper time for removal from the heat source.

Special heating devices have been developed for shrinking Thermofit sleevings to general and specific configurations.

ELECTRONIC component of complex shape (bottom) has been encased in heat-shrinkable sleeving shown (top) before shrinking.

Styrene foam containers

Molded polystyrene foam containers for safe shipping of delicate gear-pump parts are about 55% lighter with average load and 10% less bulky than wood and steel boxes previously used.

According to W. H. Nichols Co., Waltham, Mass., which makes the parts on contract from Zenith Products Co., West Newton, Mass., the weight and size reductions permit 20% lower shipping costs.

The foam container measures 18 by 18 by 4½ in. and weighs about 24½ lb. with an average shipping load. The former box, 20½ by 11¾ by 6¾ in., weighed about 43 lb. with the same load.

The new container consists of two identical halves, bound together by rayon filament-reinforced tape supplied by Minnesota Mining & Mfg. Co. This method replaces nailing and steel strapping of the wooden box.

Pump parts are cushioned by PS foam insert trays, which replace steel tote trays. Container halves and insert trays are molded by Expandex Inc., Wauregan, Conn., which uses its own equipment and expandable foam beads from Dow Chemical Co. Single-cavity molds are used for the container halves, and two-cavity molds for the insert trays.

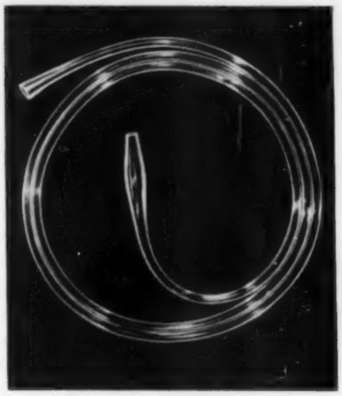
Novel design for medical tubing

Integral funnels and tapered connector ends engineered into recently introduced Argyle medical and surgical tubing permit ready attachment to other tubing or apparatus without need for separate fittings, connectors, etc. The tubing is supplied by A. S. Aloe Co., a div. of Brunswick Corp., and was developed by David S. Sheridan, pres. of Sheridan Catheter and Instrument Co., Argyle, N. Y., a subsidiary of Aloe.

The tubing is extruded from a formulation based on B. F. Goodrich Co.'s Geon vinyl. Both the tapered and funnel ends are produced during the takeoff portion of the extrusion cycle—although exactly how, the company will not reveal.

The big advance represented by this tubing is the fact that the built-in continuous taper makes it possible to effect connection to many diameters.

While presently produced tubing is primarily intended for medical use, industrial and laboratory applications are an obvious extension. For example, just one size of Argyle connectors can replace as many as 20 different sizes of conventional connectors, thereby eliminating a major inventory problem.



All Argyle tubes are produced water clear, except oxygen catheters, oxygen tubes, cannulae, and connecting tubes which are green, the standard color for oxygen accessories.

According to the company, Argyle tubes are economical enough to make one-time use feasible. However, they can be cleaned, sterilized, and re-used if desired.—**End**

WHAT'S NEWS IN ENJAY TECHNICAL SERVICE

Enjay helps reduce cost of 90°C vinyl wire insulation...

An important part of Enjay Technical Service is developing useful new products that reduce costs, yet maintain performance. Ditridecyl phthalate for use in plasticizing vinyl wire insulation is a good example of this research activity. By tests, such as the oven aging shown above, Enjay was able to prove that DTDP, made from Enjay tridecyl alcohol, performs as an efficient, non-volatile plasticizer for 90°C wire — yet reduces plasticizer cost.

Test results, at right, show that the insulation exceeds the U.L. Specifications.

Enjay research facilities and technical skills are available to customers in the vinyl wire, film and sheeting industries.

If you would like to receive a free copy of our new Technical Bulletin No. 20 on Enjay oxo alcohol for plasticizers, write to 15 West 51st Street, New York 19, N. Y.

TEST RESULTS: 7 DAYS @ 121°C

	U. L. Specification Minimum	DTDP Plasticizer
Elongation	65% retention	100% retention
Tensile Strength	65% retention	101% retention
Dielectric Strength	50% retention	127% retention
Insulation Resistance*	.01 megohm based on 1000 ft.	0.36 megohm based on 1000 ft.

* 1 day and 7 days @ 113°C.

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8 REASONS WHY PLASTICS MEN NOW REGARD

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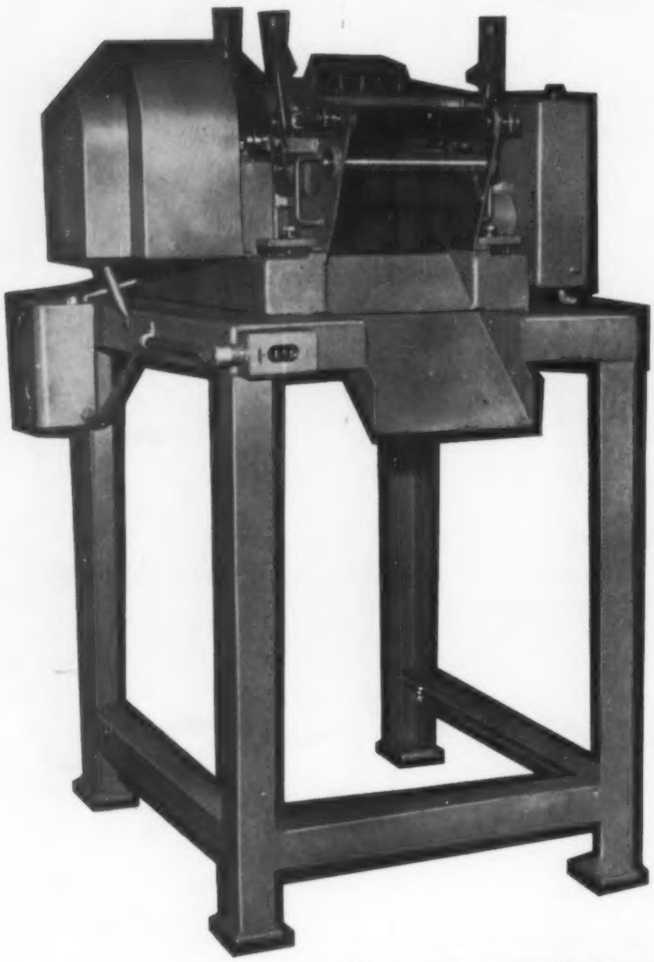

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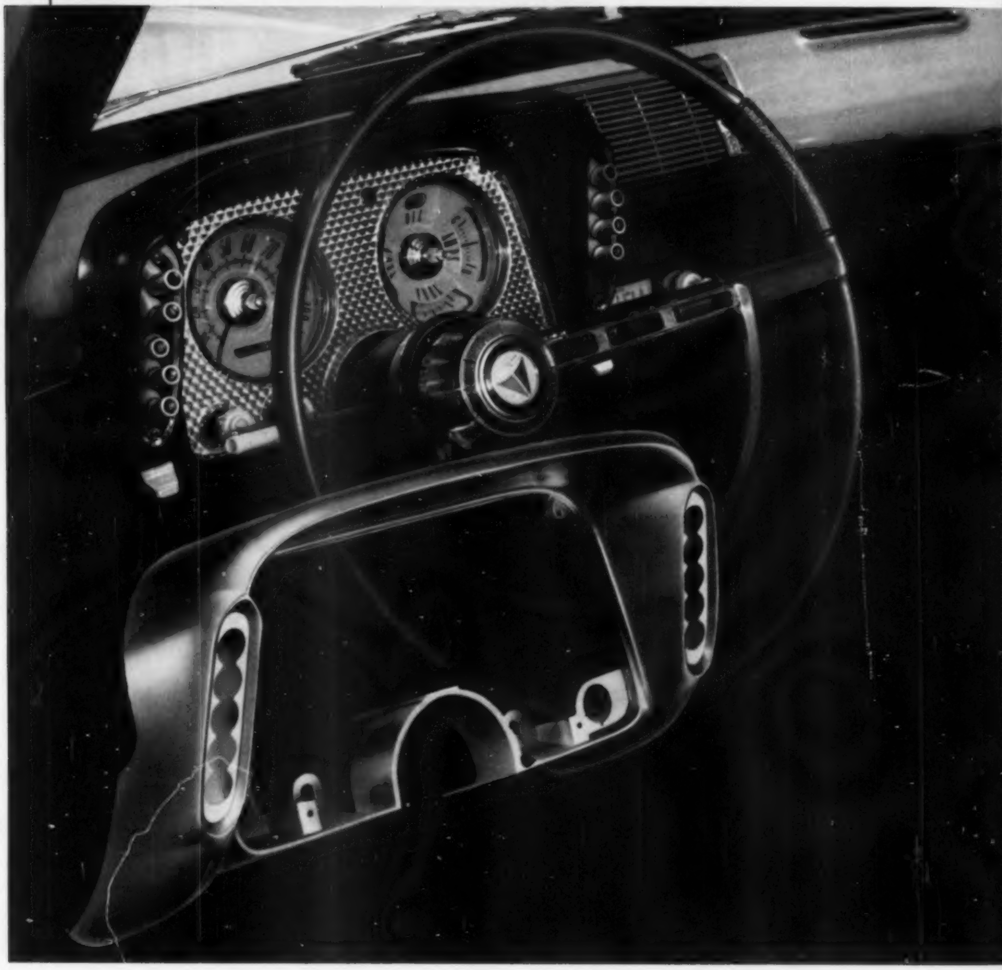

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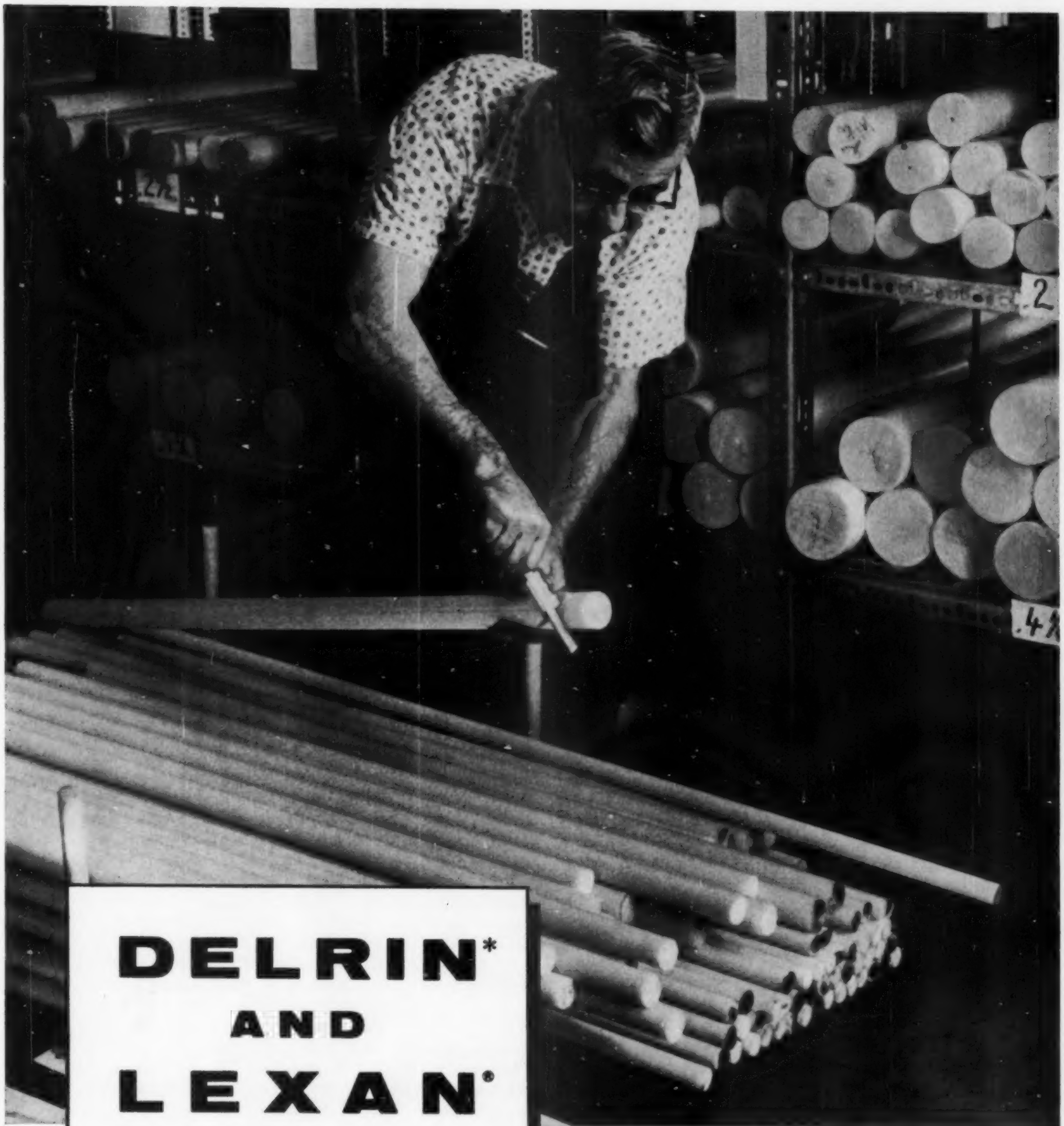

LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Manipulation of Thermoplastic Sheet, Rod, and Tube," *by J. M. J. Estevez and D. C. Powell*

Published in 1960 by Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y. 148 pages. Price: $4.85.

Two characteristics of the treatment of the subject matter make this book particularly commendable. The first is its objectivity, and the second is the thoroughness of the discussion. In addition to telling the reader what can be done with plastic sheet, it also does not hesitate to discuss the limitations of the methods mentioned and the results which may be expected. Topics covered are the machining of primary shapes, decoration of the product, cementing and welding techniques, thermoforming (using manual, vacuum and pressure techniques), and combination fabrication techniques using several methods in concert. Sufficient detail is given in the description of each method so that the reader can immediately apply the information to practical problems. An excellent handbook for fabricators working with sheet and other primary shapes of thermoplastics.—*G.R.S.*

Vacuum coaters. Specifications, capacities, uses, etc., for a line of vacuum coaters, and other high-vacuum components and equipment. 8 pages. *NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass.*

Diallyl phthalate varnishes. Resin cures, application, processing, viscosity vs. resin content, catalysts and cure time, and other technical data on the formulation and use of insulating varnishes based on Dapon diallyl phthalate resins. Bulletin 32. 8 pages. *Dapon Department, Food Machinery & Chemical Corp., 161 E. 42nd St., New York 17, N. Y.*

Vinyl resins. "Bakelite Vinyl Resins for Solution Coatings" is a how-to booklet on vinyl solution coating formulation techniques. Includes general properties, uses, formulations; preparation of clear and pigmented coatings; and tables listing pigments and dyes suitable for tinting vinyl finishes. 36 pages. *Union Carbide Plastics Co., 270 Park Ave., New York 17, N. Y.*

Custom molding facilities. Brochure describes the injection, compression, and fibrous glass molding facilities, and shows a variety of products produced. 4 pages. *Automatic Plastic Molding Co., 830 Bancroft Way, Berkeley, Calif.*

Fibrous glass fabrics. "Stevens Fiber Glass Fabrics for Industry" lists specifications, prices, uses, etc., for fibrous glass fabrics, woven rovings, and tapes for the electrical, reinforced plastics, and coating industries. 36 pages. *J. P. Stevens & Co. Inc., Industrial Glass Fabrics Dept., Broadway and 41st St., New York 36, N. Y.*

Electrical heating units. Specifications, uses, prices, and features for a line of air heaters, clamping bands, and other electrical heating units and equipment for the plastics and other industries. Catalog CS-600. 24 pages. *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

Spray painting machine. Describes a whirling gun automatic spray machine which continuously whirls two opposing guns or holds them in fixed position for the painting of round, deep-draw, and intricately designed plastics parts with diameters up to 15 inches. 2 pages. *Conforming Matrix Corp., Toledo Factories Building, Toledo 2, Ohio.*

Polyethylene resins. Data sheet lists characteristics and applications for 31 of the most commonly-used Petrothene PE resins. 4 pages. *U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y.*

Polystyrene, PE. Product Data Guide gives properties, uses, test method data, etc., for Elrex Polystrenes. 4 pages. Film Resin Product Data Guide lists similar information for Elrex polyethylenes. 6 pages. Molding Resin Product Data Guide includes similar material for Elrex polyethylenes. 6 pages. *Rexall Chemical Co., P. O. Box 37, Paramus, N. J.*

Product guide. Outlines properties, limitations, etc., for a group of synthetic rubbers and plastics: Neoprene, nitriles, Thiokol polysulfide polymer, silicones, PVC, polyesters, PE, phenolics, Teflon, and Hypalon, a chlorosulfonated PE. Rubber Guide Bulletin P2. 12 pages. *Stowe-Woodward Inc., Newton Upper Falls 64, Mass.*

Fluorocarbons. Bulletin recommends methods of machining this company's reinforced Teflons (Duroids 5600 and 5800 series). Includes handling; tools and work setup; heavy machining; drilling, reaming, tapping, finish grinding; etc. TSB No. 127. 2 pages. *Rogers Corp., Rogers, Conn.*

Fibrous glass reinforced plastics. Describes resins, reinforcements, and releases used in laminating and casting, including technical data on contact and spray-up molding. Outlines properties and handling procedures for polyester, epoxy, and foam-in-place resins. Includes 24-plate chart of color paste dispersions. Catalog C. 32 pages. *Allied Resin Products Corp., Hingham Industrial Center, Hingham, Mass.*

Nylon-molybdenum disulfide molding compound. Physical properties, formulations available, applications, etc. for Nylatron GS. Includes 45 case histories. 4 pages. *The Polymer Corp., Reading, Pa.*

Plastic and Chemical Materials covers product features, applications, technical data, etc., for this company's line of Lexan polycarbonate resin, phenolic molding powders, phenolic resins and varnishes, Methylon coating resins, and fused magnesium oxide. 12 pages. *General Electric Co., 1 Plastics Ave., Pittsfield, Mass.*

Production facilities. Brochure describes the design, molding, and tooling facilities for this company's plants in Minnesota, Iowa, and North Carolina. 12 pages. *Northwest Plastics Inc., 65 Plato Ave., St. Paul, Minn.*

How to Work with Plexiglas gives detailed information on machining, forming, finishing, and joining of Plexiglas sheets and other acrylic shapes. Machining operations, illustrated by 60 drawings, include layout, cutting, sawing, punching, drilling, routing, shaping, and turning. Also covers forming by the hand, jig and clamp, plug and ring, drape, blow and vacuum methods. 20 pages. *Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.*

Plastics for Packaging—Last Step in Manufacture, First Step in Sales describes a variety of applications based on Tenite butyrate, acetate, propionate, PE, and polypropylene. 20 pages. *Eastman Chemical Products Inc., Kingsport, Tenn.*—**End**

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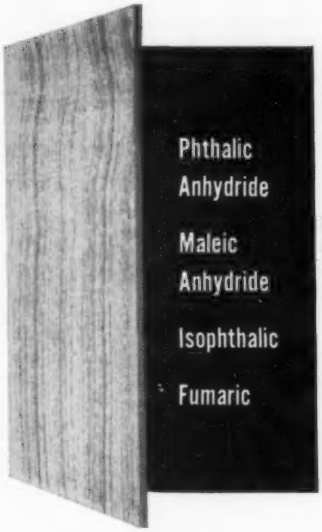

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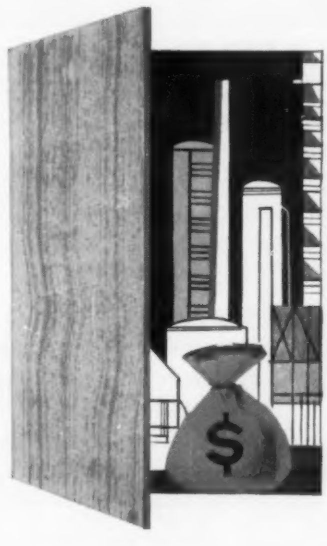

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7016

PE coatings

(From pp. 84-87)

time. Growing end-uses are in military packaging and as a wrapping for bar soap, in which a foil/PE/paper wrap prevents the natural oils of the soap from migrating through to the outer carton. A paper/foil/PE combination is used extensively today as a light- and moistureproof wrapper for the packaging of photographic film.

Cellophane is coated with PE primarily to provide a flexible, tough, and moisture resistant pouch package. The packages, in the food field, are widely used for liquid-containing products, candy, and luncheon meats.

A leading end-use for PE-coated polyester film is for packaging frozen foods which can be heated right in the bag. With this material, it is practical to package processed meat or pre-cooked foods in a transparent film pouch that will hold a vacuum, withstand shipping and handling, and protect the contents until served, even through freezing and boiling. In addition to durability, clarity, and extremely low gas permeability, this film combination guarantees a completely hermetic heat seal. Heatable bags consume between 700 and 750 thousand lb. of polyethylene at the present time.

Polyethylene coating on paperboard has only within the past two years reached any significant level —about 5½ to 8 million lb. of resin—but it could conceivably be the largest single end-use for PE in the near future. Coating for milk cartons alone represent a potential of between 100 and 150 million pounds. While the PE coating adds about $2 per thousand to the price the dairy pays for cartons, it does not flake off into the milk and offers high resistance to carton leakage. Carton stock is coated on both sides with ½ to 1¼ mil of PE. The coating weight for such milk carton applications averages around 20 lb./ream.

Coated board stock finds its greatest use as trays in the bakery and meat industries. Coated stock for frozen food boxes has been slow to develop, but here again, potential is great—20 million lb. or more of PE, probably within two years.

There is a market **(To page 162)**

Formed entirely in one piece, this seamless plastic blinker housing measures 24" long, 8¾" wide, and 1½" deep at its narrowest part. It is molded by DeWitt Plastics, Auburn, N. Y. for Roberts Enterprises, Inc., Cazenovia, N. Y.

STOP...LOOK WHAT'S NEW

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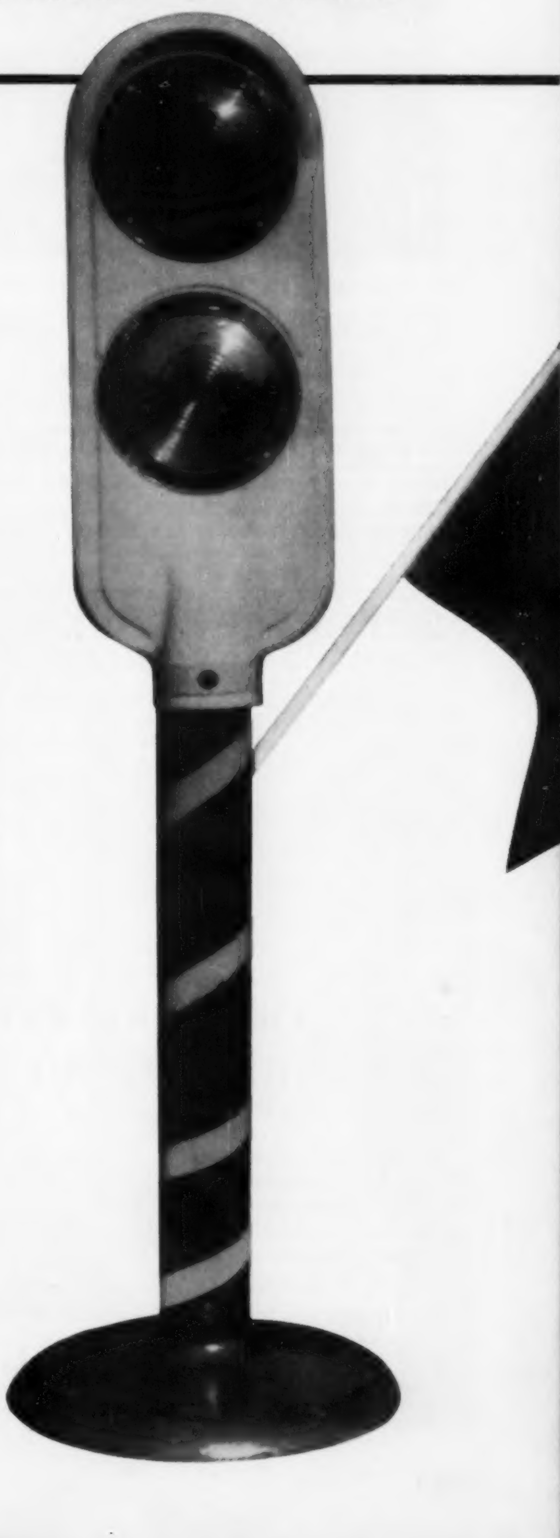

This flashing road barricade is a beacon of safety for motorists. Its yellow plastic blinker housing shows something else, too. Good design. Selection of the *right* process, the *right* material. Only blow molding could make this part in one piece. And BAKELITE Brand high-density polyethylene provides the durability to stand long, tough outdoor use.

The background of UNION CARBIDE in blow molding dates from the earliest application of polyethylene to squeeze bottles. At our laboratories in Bound Brook, N. J., a battery of all major types of blow molding machines reproduces practically every set of production line conditions encountered in the process. As a result, BAKELITE Brand polyethylenes are engineered for performance in machine and product alike.

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UNION CARBIDE

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of about 2 million lb. for PE in coating paper for freezer wrap and butcher's meat wrap. One interesting product in this field is a coated, stretchable kraft paper for the wrapping of irregularly-shaped cuts of raw meat. Greater protection against puncturing by sharp bones is provided by the combination of PE and a paper with "give" to it. Polyethylene-coated bread wrap is just now starting to show signs of major growth.

Polyethylene extrusion coatings have been slow to move into the area of corrugated containers, since the adhesives used in fabricating the corrugated board require setting temperatures sufficiently high to impair the coating. For increased penetration by PE coatings into this field, adequate cold-set adhesives will need to be developed.

Not all packaging applications of PE coatings are for food items—nor can they all be classified as "consumer" packaging. Both nonfoods consumer items and industrial products make use of such packing material.

Polyethylene-coated paper is used today for wrapping a range of products from rosebush roots to sheet steel. In nursery wraps, the coated material permits little or no transmission of moisture or moisture vapor, thus sealing essential dampness in plant roots and preventing drying out of the plants.

Coated kraft paper, now used for wrapping high-finish lumber, protects the wood from weathering damage, and provides brand identification on a product normally shipped in an unwrapped fashion. Another product which has been protected during shipment by coated paper wrapping is automotive-grade sheet steel.

Non-packaging applications

Cited at the beginning of this article were several non-packaging uses for PE-coated materials. Actually, this market does not amount to more than 10 million pounds of resin. However, the list is varied enough—products range from disposable baby diapers to automobile door liners—to interest a broad segment of industry in their use.

Consider, for example, the great mass market for inexpensive luggage, the kind you can use for summertime trips to the beach without

the worry that you are subjecting $50 to $100 luggage to unwarranted abuse. Several manufacturers have successfully used PE-coated kraft paper as the outer surface of such low-cost luggage. The luggage usually has a 2-mil coating of PE on kraft, which in turn is bonded to inexpensive wood or chipboard reinforcement. The result is luggage which sells for 40 to 50% below the price of top-grade leather luggage. One manufacturer uses high-density resin for maximum abrasion resistance in the luggage surface, and also supplies the luggage with a number of various embossed designs.

A volume of about ¾ to 1 million lb. of PE exists today for coated paper for construction use. The paper is almost entirely heavyweight kraft, often with such fiber reinforcement as sisal. The PE is often pigmented for special purposes. When used as a water and moisture vapor barrier, under concrete slabs or to cover crawl spaces, the resin can be pigmented black for maximum weathering resistance. When used as a cement curing paper, the resin is often pigmented white to reflect the sun's heat and light, permitting natural curing of the cement material. These heavy-duty combination materials have reportedly been used as flashing around roof gutters and drains, but the volume involved in this use is quite small.

One end-use area that could mean a considerable boost in consumption of PE coating resins is in covers for booklets and pamphlets. At the present time, the volume involved in this field is practically nil, a rare application being a glossy PE-coated cover for the annual report of a polyethylene supplier. But there are signs of interest in PE-coated roll stock for covers of Sunday supplements by several newspaper publishers, and further interest by producers of phonograph albums.

The annual report covers mentioned above, used each year since 1957, consist of gravure-printed white roll stock coated on one side with ½ mil of polyethylene. The coating imparts durability and moisture resistance to the cover, will not crack at the cover's fold, and upgrades the quality of the finished product.

Coated burlap for tarpaulins

A flexible storage system for military ordnance equipment now incorporates PE-coated burlap to protect the equipment against corrosion and humidity. Using this system, 10-oz. burlap, coated on each side with 4 mils of PE, is suspended by hooks inside unheated sheds. Low relative humidity is maintained within these tent-like structures to protect such equipment as lathes, gages, office equipment, and electric motors from corrosion and rust caused by high humidity. There is no need to strip down the equipment, coat each part with grease, or individually wrap each part for storage. In one tent installation, it has been estimated that the use of burlap huts, with each hut housing 15 air compressors, resulted in an annual saving to the Army Ordnance Corps of approximately 100 man hours per compressor for required inspection and maintenance. Coated bur-

lap can also be used for the outdoor storage of heavy machinery, firebrick, and lumber.

Sources in the PE resin industry report that certain automobile makers are using coated paper and textiles in their current car models. While not confirmed by the auto industry, it is known that one leading body company has applied black-pigmented PE-coated kraft as a water vapor barrier lining inside car doors. Another major manufacturer uses a PE-coated textile material as a liner underneath floor carpeting for protection against moisture.

Paper cups and plates with PE coatings have appeared on the retail market within the past few years. The items, fabricated from coated paperboard, are impervious to hot liquids, grease, and sticky foods for long periods of time, and are also glossier and more attractive than waxed or uncoated counterparts. And here's another use for coated paperboard—a backing for blister packages, used for protecting fragile items during long-distance moving operations. The PE coating on the board serves as a heat-sealing base for the heat-shrink film used to package the household items.

Looking ahead

By 1963, PE extrusion coatings, by various estimates, will reach 100 to 150 million lb., with opinion generally leaning toward the higher figure. All speak of coated milk cartons as being the growth leader, reaching a potential of between 50 and 70 million lb. within the next two years and, not unreasonably, doubling in volume during the two or three years after that. Coated pouch packages will follow close behind in growth, reaching an estimated 50 million lb. by the middle of the 1960's.

A lot of the future success of PE coatings is dependent upon systems of minimizing waste, of recovering paperboard fiber and perhaps the polyethylene coating web trim. Savings of 1 or 2% by means of these systems could be a big boon to paper and paperboard converters. Since the converters initiate many new developments in coated materials today, a rise in their profit margins could open the way for a step-up in product research and development.—**End**

Urethane elastomers

(From pp 88-89)

tests prove to be successful, the 5% figure will soon be surpassed.

Another overlapping market area is in monofilaments. This comprises a 15-million-lb. market, mostly represented by monofilaments that can be made into elastomeric thread. An obvious application is in ladies' undergarments. An interesting property of this extruded filament is that it has the dyeing characteristics of wool and a tear strength that is three times that of rubber.

A third competitive area is represented by heel lifts, a 1.5- to 3-million-lb. annual market. Heel lifts represent the first commercial application for the new materials. Urethane elastomers are said always to have outperformed nylon and steel lifts; now that they are injection moldable, they can do so economically.

Another overlapping market comprises tubing for oils, gasoline, and similar liquids, where the urethanes are replacing copper and other plastics for price reasons. They are also replacing rubber in gasoline lines because rubber does not have the necessary solvent resistance.

A fifth market, but one that is likely to be dominated by the thermoset urethane elastomers, covers products generally classified as "mechanical rubber goods." These include gears, bushings, gaskets, industrial wheels and the like. These items consume approximately 500 million lb. of rubbers and cast urethanes a year. Elastomeric urethanes are expected to capture 5 to 10 million lb. of this total. They are thought to have a particularly strong position in applications for which nitrile rubber and Neoprene are now specified.

A typical application is the lubrication seal found in the 1961 Ford line. Ford now sells these cars with a guarantee that they require lubrication only every 30,000 miles. This guarantee is made possible by the fact that the urethanes have sufficient resistance to gasoline and oil solvents to remain effective for such a long period. Such seals have till now been compression molded

Properties of Estane urethane elastomers

Property	*5740 × 1 (Extrusion)*	*5740 × 2 (Solution coating)*	*5740 × 7 (Injection)*	*Test method*
Hardness	88A	70A	49D	Shore Durometer
Tensile strength, p.s.i.	5840	5000	5840	D412-51T
Elongation, %	540	720	490	D412-51T
Tensile modulus, p.s.i. 300%	1240	420	2800	D412-51T
Compression set, % at 25° C., 22 hr.	39	42	31	D-395
Specific gravity	1.2	1.2	1.2	

Properties of Texin urethane elastomers (as postcured)

Property	*280A (Extrusion)*	*194A (Injection)*	*355D (Injection)*	*Test method*
Hardness	80A	94A	55D	Shore Durometer
Tensile strength, p.s.i.	65 to 8000	45 to 5500	40 to 5000	D412-51T
Elongation, %	550 to 650	550 to 650	500 to 600	D412-51T
Tensile modulus, p.s.i. 300%	18 to 2000	22 to 2400	24 to 2600	D412-51T
Elongation set, %	10 to 20	40 to 50	40 to 50	D412-51T
Tear strength, lb./in.	3 to 400	3 to 400	3 to 400	Fed. Spec. FTMS-601 M-4331
Specific gravity	1.25	1.25	1.25	

The Holoform machine operates in conjunction with extruder of customer's choice.

of cast sheet. But they can now be injection molded and no doubt will be, bringing definite savings to the auto industry.

In another application, cast urethanes are used as a pneumatic hammer stop. Prior to the introduction of the molding grades, these stops (essentially thick washers) were cast and then machined to proper size (dimension is very critical in this application). These stops can now be injection molded and require no post-molding machining.

There are apparently many markets in a wide range of industries that the thermoplastic urethane elastomers are after; however, many of these are in the development stage and no specific instances are available. But they cover the automotive field, packaging, appliances, building, transportation, pocketbooks, and others.

What materials are available

Two materials suppliers are now in this field: B. F. Goodrich Chemical Co., Cleveland, Ohio; and Mobay Chemical Co., Pittsburgh, Pa.

Goodrich's material, introduced about a year ago under the trademark Estane, is the true thermoplastic urethane elastomer, selling currently at $1.85 per pound. Being fully thermoplastic, the material can be recycled indefinitely, so that there is no waste in sprues and runner systems. Several formulations are offered, each specifically designed for injection molding, extrusion, or solvent coating. The typical properties of these respective formulations are listed in the table on p. 166.

The material is supplied in rubbery 3/16-in. cubes of amber color and is processed very much like plasticized polyvinyl chloride. Goodrich suggests that, for injection molding and extrusion, a minimum compounding should include lubricants as well as the required pigments.

Injection molding is standard, with stock temperatures in the range from 360 to 375° F., and injection pressures of 20,000 p.s.i. Cycle time ranges from 30 to 90 seconds.

Extrusion is also standard, except that more cooling is required than for plasticized PVC to prevent deforming the extruded shape during take-up. Stock temperatures

range from 340 to 350° F., and most vinyl or polyethylene screws are suitable for use with Estane.

Estane can also be compression molded at stock temperatures of 350 to 360° F. and on 15-min. cycles, using pressures of 500 to 1500 p.s.i.

The Mobay material has just been introduced under the tradename Texin (*T*ransfer molding, *EX*trusion, *IN*jection), and sells for $1.45 per pound. It is not a true thermoplastic and can be recycled only up to a point. The material is supplied in pellets as "green stock" (green refers to its uncured state, not its color; its natural color is amber). During injection, the green stock flows into the mold cavity where it solidifies. On removal and without further treatment, the molded item exhibits a good percentage of some of its final properties. Some molders use the product as molded; however, Mobay recommends postcure at 220° F. for 6 hr. (or 166° F. for 24 hr.) to crosslink the material completely and bring it to its maximum property values. The material is offered in several formulations. Properties are listed in the table on p. 166.

Prior to cure, the material can be reworked. However, since some slight crosslinking takes place every time the material goes through the machine, increasingly higher temperatures may be required during successive recycles. Finally a point is reached where the stock has become fully crosslinked and is no longer reworkable. Normal temperatures for injection molding range from 325 to 375° F., and injection pressures from 500 to 600 p.s.i.

The green stock can also be extruded with conventional machines and dies. Screw length-to-diameter ratios of 15:1 to 20:1 are suggested. The material emerges from the die relatively dry and need not pass a water bath. It is simply carried by belt conveyor to the windup station. Elastomeric properties are such that extruded monofilament, cured in the stretched state, has a tensile strength of about 10,000 p.s.i., elongation of 400 to 500%, and a tear strength three times that of rubber . . . yet it recovers fully after elongation. While after-molding cure is optional, extrudates must be cured to provide the lowest elongation set.

Transfer molding is also standard and in one instance ran 15 times faster than with rubber.

The prospects

It should not be assumed that moldable elastomeric urethanes will ever fully replace the cast system in its 50-million-lb. market. The cast system is still the most economical in many shapes, sizes, and contours. What the new materials are expected to do is to cut into those markets where the earlier cumbersome production technique prevented penetration by urethanes. However, as indicated above, some of the products currently cast will certainly switch to molding. It is too early to tell now whether casters will acquire plastics processing machines to participate in this market, or whether companies now in the plastics market will become the major factor. Whichever way it goes, it still has potentials for becoming a big business.—End

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Dibutyl Sebacate	0.935	7.9	Vinyl Resins, Cellulose Acetobutyrate, Synthetic Rubbers, Rubber Hydrochloride, Polymethyl Methacrylate	Low Temp. Flexibility, Excellent Aging Qualities, Non-Toxic
Dimethyl Sebacate	0.986*	3.54 @30°C	Vinyl Resins, Synthetic Rubbers, Cellulose Nitrate, Cellulose Acetobutyrate, Acrylic Resins	High Solvency and Efficiency, Wide Compatibility, Concentrated Source of Sebacyl Radical
Dioctyl Sebacate	0.913	17.4	Polyvinyl Chloride and Copolymers, Polyvinyl Butyral, Synthetic Rubbers, Cellulose Nitrate, Cellulose Acetobutyrate	Excellent Low Temp. Flexibility, Low Volatility, Excellent Soapy Water Resistance, Good Electricals

*30°/20°C

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Manufacturers' Literature

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EQUIPMENT • SUPPLIES • SERVICES

EXTRUSIONS. 8-page illustrated book describes company that produces rigid or flexible plastic extrusions to individual specifications. In rigid vinyl, elastomeric vinyl, polyethylene, styrene, cellulose acetate, acrylic, etc. Typical applications, advantages, other data. Crane Plastics, Inc. (101-C)

FOAM SYSTEMS. Two bulletins describe "infusible" foam systems with unique high-amp temperature resistant properties and polyether foam systems with intermediate heat resistant properties. Outstanding advantages, product information, test results, notes. The Carwin Co. (102-C)

AXIAL PISTON PUMPS. 8-page illustrated booklet describes line of piston pumps for continuous industrial service —up to 5,000 psi. Variable volume and constant volume. Also describes line of motors and controls. Advantages, applications, other data. American Brake Shoe Co., Denison Engineering Div. (103-C)

MAGNETIC SEPARATORS. 6-page illustrated folder describes magnetic separators for the process industries. Designed for liquid suspensions at all viscosities and for powdered and granular materials. Advantages, specifications, schematic diagrams, price list. S. G. Frantz Co., Inc. (104-C)

DIALLYL PHTHALATE RESIN. 12-page book describes Diallyl Phthalate Resin—commercially available as a dry, free-flowing white powder. Discusses advantages over other plastics, applications, molding compounds, resin blends, decorative and industrial laminates, other basic data. Food Machinery & Chemical Corp., Chemicals & Plastics Div. (105-C)

HIGH DENSITY POLYETHYLENE. 20-page illustrated book lists 101 ideas in high density polyethylene. Discusses design considerations such as section thickness, fillet radius, draft, parting lines. Lists physical, electrical, and chemical properties of high density polyethylene. Also future applications. W. R. Grace & Co., Polymer Chemical Div. (106-C)

WELDING. 4-page illustrated folder describes new dot welding process—for filling metal cavities, undercuts, scratches and imperfections in dies or molds. Advantages, applications, other data. Mid-States Welder Mfg. Co. (107-C)

VINYL STABILIZERS. 16-page illustrated book describes diversified series of vinyl stabilizers. For calendering, extruding and injection molding applications; also plastisols and modified pastisols. Complete product information, applications, use in special fields, and special effects. The Harshaw Chemical Co. (108-C)

EXTRUDING. Folder with specification sheets covers line of extrusion screws, extrusion equipment and sheeting dies. Detailed schematic diagrams, photographs, other data. Johnson Mfg. Co. (109-C)

TEXTILE YARNS. Comprehensive 12-page brochure describes fiberglas manufacture from raw materials to eight different types of yarns and textile fibres—regular, colored, bonded strand, etc. Physical properties, fibre comparison chart, applications, other data. Johns-Manville, Fiber Glass Div. (110-C)

DISPOSABLE WIPERS. 12-page illustrated booklet, with sample, describes soft, highly absorbent cellulose wipers that wipe clean quickly, wet or dry. Industrial uses include general purpose wiping, cleaning and polishing. Kimberly-Clark Corp. (111-C)

POLYETHYLENES. 8-page illustrated booklet describes complete line of polyethylenes—including low, medium, and high densities. Physical characteristics, physical properties, other data. Koppers Co., Inc., Plastics Div. (112-C)

LAMINATING. Multi-page catalog with spiral binding describes continuous film laminating system for plywood, metal or semi-rigid substrates. Advantages, applications, blueprints, photos and other data. The C. A. Litzler Co., Inc. (113-C)

ORGANIC PEROXIDES. 6-page reprint discusses organic peroxides as catalysts. Covers types of organic peroxides, vinyl polymerization, polyesters, selection of a peroxide, storage, stability. Charts, other data. McKesson & Robbins, Inc., Chemical Dept. (114-C)

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NACREOUS PIGMENTS. 8-page illustrated brochure describes natural and synthetic nacreous pigments. Includes discussion of dispersion, formulations, application procedures, etc. Advantages, outstanding properties, other data. The Mearl Corp. (117-C)

INDUSTRIAL FUNGICIDES. Catalog describes complete line of industrial fungicides, including copper, copper 8-quinolinolates, mercurials, zincs, organic fungicides, metallo-organic fungicides, and preservative formulations. Complete information, applications, prices, other data. Nuodex Products Co. (118-C)

FIBER GLASS. Folder with catalog pages describes custom molded fiberglass for industry, including fume hoods, process and plating tanks, exhaust stacks, pans, troughs, and duct work. Also covers orthophthalic polyesters. Poly-Fibre Associates, Inc. (119-C)

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INJECTION MOLDING. 4-page folder describes line of plastic injection molding machines that offer greater moldability, faster molding speeds, longer strokes, new safety circuit, etc. Complete descriptions. Package Machinery Co., Reed-Prentice Div. (123-C)

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REINFORCING MATERIALS. 24-page book describes extra strong, lightweight reinforcing material for molding with thermosetting and thermoplastic resins. Offers solutions to problems of surface, abrasion-resistance, chemical-resistance, stain-resistance, wicking, electrical properties—wet or dry. Troy Blanket Mills. (131-C)

URETHANE POLYMERS. Assorted technical bulletins cover various subjects, including safety precautions, for handling urethane polymers for foam casting and coating applications; liquid urethane prepolymers for use in compounding elastomeric, semi-rigid and rigid plastics; release agents, etc. Thiokol Chemical Corp. (132-C)

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POLYVINYL MATERIALS. 20-page illustrated catalog describes features and applications of a rigid thermoplastic sheet. Charts and tables. B. F. Goodrich Chemical Co., Div. B. F. Goodrich Co. (142-C)

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Architectural wonder

(From pp. 100-102)

were used in the resin for an interesting decorative effect. Covering these benches required more than 2000 sq. ft. of glass cloth.

Use of plastics begin with the very exterior of the building itself. The entire surface of reinforced concrete is protected by a tough, flexible, weather-resistant vinyl coating. More than 1200 gal. of coating material were used.

Application began with a prime coat which penetrated and sealed the surface of the concrete. This was followed by a second spraying of aluminum pigment, which contributed an improved vapor barrier. Finally, two layers of the white-pigmented vinyl coating were applied. Total cost of the plastic coating was approximately 45¢ per square foot.

RP for pools, PVC for piping

If plastics create beauty and comfort for spectators, they also assure health and well-being for the marine stars of the show. Complete facilities for producing a supply of "sea water" for the porpoises and other aquatic animals in the exhibit and an efficient circulating system, capable of changing the entire supply of water every 90 minutes, use plastics to advantage. Resembling a huge flying saucer poised for flight, the main pool structure has a sprayed-on vinyl-based coating 20 mils thick to color and protect its entire surface.

Because salt water is used throughout the new exhibit, the architects naturally specified wherever possible corrosion-resistant plastics, which would reduce maintenance and replacement problems to a minimum. Thus the pool lining, of glass-reinforced epoxy construction, is immune to the salt water used in the tank and also resists formation of algae.

In lining the porpoise tank, one layer of epoxy resin was first applied by roller to the bottom and sides of the pool; three additional coats of aqua-tinted epoxy resin followed, with the last sprayed on to produce a smooth-finished surface. Nearly 700 lb. of cloth, along with some 1500 lb. of epoxy resin, were used in surfacing the tank. In addition to the main tank, which

ranges in depth from 4½ to 16 ft., three smaller pools at each end of the tank and two outside the main building were similarly protected.

Polyvinyl chloride piping

Approximately 2000 ft. of PVC piping, in diameters ranging from 1½ to 12 in., were used in the Seven Seas project. The primary reason for using PVC piping was to eliminate at the outset the problem of corrosion, which would otherwise have arisen from salt water circulating throughout the installation. While it would have been possible to use stainless steel piping for corrosion resistance, the cost of the metal itself, as well as fabrication and installation costs, would have been prohibitively high.

The PVC pipe, because of its light weight, was relatively easy to handle even in the larger diameters. Fabrication posed no special problems, and thanks to the thermoplastic nature of the product, it could be heated and shaped in forms to fit some of the curving contours of the pool building—a feat which would have been out of the question with large-diameter metal piping. Pipe in the various diameters used was delivered to the plumbing contractor's shop in 10- and 20-ft. lengths for fabrication.

The installation also includes some 2200 PVC fittings, some of which were fabricated and others molded. Flanged joints were used on all connections for pipe from 2½-in. diameter and up, and socket joints for smaller diameters. All joints were solvent sealed and no threaded connections were involved. Total cost of the plastic pipe and fittings on this project is estimated at approximately $85,000. Because of its corrosion-resistance, the PVC pipe is expected to last for many years with little or no need for servicing or replacement.

Architects, engineers, and construction men who wish to see how plastics can be put to effective use in modern building construction will want to take a close look at the Brookfield Seven Seas Panorama. Although many of the plastics applications in this project were selected to meet special problems, they illustrate the adaptability of selected plastics in the construction field when their unique properties can be used to advantage.—End

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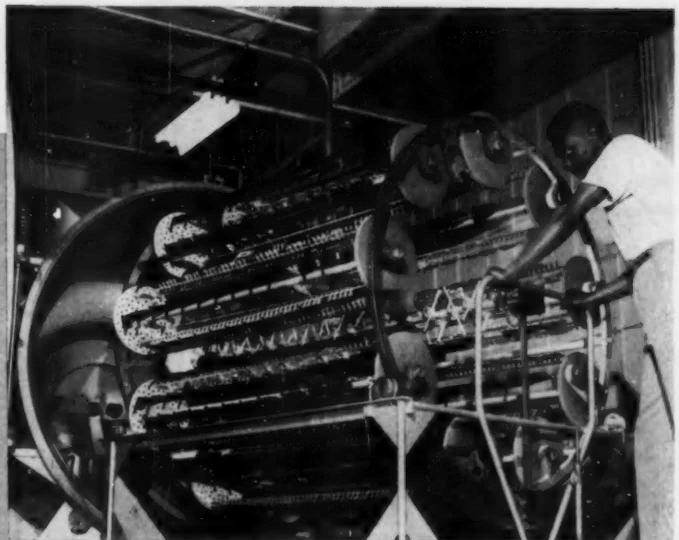

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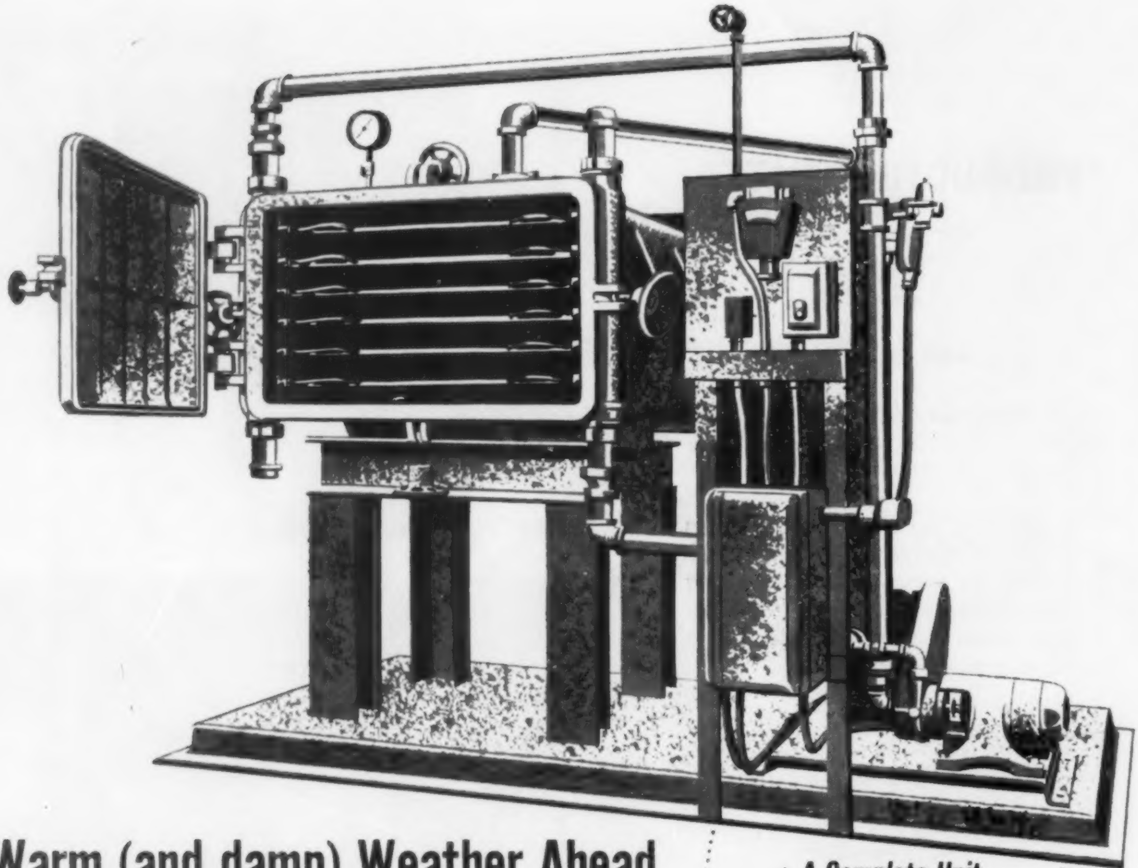

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Lenses

(From pp. 90-93)

minimum pressure needed to prevent leakage. The mold assembly is cured in the vertical position so that any air which might be drawn into the mold during cure will form a minute bubble at the top of the mold (e.g., at the edge of the lens) where it will be least objectionable.

With ophthalmic lenses, the prescription commonly requires a toroidal surface on one side of the lens combined with a spherical surface on the other. This requirement, plus the specification of center thickness, calls for the use of over 500 different gaskets to cover the range of such lenses manufactured by APC.

The process described above can be used to cast lenses which meet prescription specifications without any further finishing; or they can be sold in semi-finished form requiring one surface to be ground and polished by the optical laboratory prior to dispensing to the patient.

Lenses are cured in a program-controlled cycle, exponentially rising from 90 to 200° F. over a period of 16 hours. The cycle is designed to maintain a uniform rate of polymerization.

Ophthamologists, generally speaking, look upon plastic lenses with favor. There is only one basic shortcoming, but it is one that has been a big stymie to the broadening of the plastics market base in this area: scratch resistance. Allyl lenses, while 30 times as scratch-resistant as methacrylate equivalents, still do not approach the hardness of glass; and with the constant handling they undergo, this factor assumes some importance. In the case of aspherical and thick lenses, other considerations outweigh this poor scratch resistance. But in the case of standard prescription lenses, factors of weight and unbreakability are not sufficient to overcome the hardness problem.

There is considerable work being done by lens casters to improve the hardness of their allyl formulations. Some progress has already been made over the compounds that were originally used; but it is generally agreed that a major breakthrough will be required to drastically change the situation and bring total consumption above the 10% figures projected by American Optical.

Injection molding brings benefits

There is a large area of industrial optics where injection-molded plastics lenses have scored impressive successes. The reason: the high light transmission of methacrylate (which is the material that generally goes into these lenses) plus the economics as well as the design advantages that can definitely be gained through the process of injection molding.

The largest outlet for these moldings is in short-focal-length aspheric lenses used in the high-volume, fixed-focus cameras retailing for $15 and under. Latest trade estimates put annual production of such cameras at around four million units. Plastics have taken over about 80% of this market and are expected to absorb almost all of it. Since lenses for these goods, however, weigh only a fraction of an

ounce, total resin consumption is relatively small.

What about other cameras? Prospects are not overly bright for injection-molded methacrylate.

First, "refined" cameras are generally not produced in sufficiently high volume to take advantage of the economies of the injection-molding process.

Secondly, the refractive index of methacrylate calls for a complexity of optical curves for the various lenses that go into the lens systems used by these higher priced cameras. This again calls for additional costly tooling and, at least for the time being, puts this market beyond the reach of plastics.

A more fertile market is viewers. Plastic lenses for viewers are molded by the millions every year. One company alone produces over 3 million 2 by 4 in. lenses yearly for use on its own line of viewers.

The most powerful advantage injection-molded methacrylate lenses offer is the fact that they can be produced with integral flanges and molded-in holes (see cover illustration). This design feature, not available with glass, can bring about substantial savings in assembly cost.

One of the largest custom molding operations for injection-molded lenses is at American Optical.

Using machines ranging from 4 to 32 oz. in size and molds with six to twenty cavities, the company produces a wide range of molded methacrylate lenses. Runner systems vary from mold to mold and include pin-point, submarine, and other systems. The molds are highly polished and the lenses are ejected without the need for further finishing, except for the removal of the sprue, which is done manually. The sprues are scrapped; only virgin material is molded.

Tolerances on injection-molded lenses are the same as for polished glass in terms of focal length. Dimensional tolerances are held to ±0.002 inch.

Much injection molding of lenses has gone captive; and such corporations as Bausch & Lomb, Eastman Kodak, Argus, and others are molding their own. Companies such as Herbert George Co., which supplies Montgomery Ward, Sears, Roebuck, use custom service. From their experience it is evident that where large volumes are involved, injection-molded acrylic lenses will eventually take over from glass in terms of cost, performance, and design features.

There is one additional type of lens that is probably lower in cost than any of the others. However, it has severe limitations. It is extruded of methyl methacrylate as a plano-cylindrical profile. These lenses, such as the one illustrated on p. 93, which is extruded by Anchor Plastics Co. Inc., Long Island City, N. Y., enlarge in only one direction and leave the right-angle direction unchanged.

This brief summary has been limited to optical lenses (except contact). Related areas would include such applications as sun glasses, safety shields, headlight lenses, and other transparent applications where the object is to protect rather than to modify an image. All these applications consume a greater volume of plastics, including polystyrene, butyrate, acetate, polyesters, and acrylic.—**End**

Blow molding

(From pp. 105-110)

and the design weight do not reasonably agree, the arithmetical accuracy of the calculations should be checked. If no calculation errors have been made, the die dimensions should be re-estimated to bring the design and calculated part weights into better agreement. Note that the agreement will depend to an extent on the ability of the calculator to estimate the amount of scrap which will be involved.

In actual practice it has been found that the die and mandrel dimensions calculated by using the formulae presented produce objects with actual production weights that are within ±5% of the design weight. In a few cases, only slight changes in the mandrel or die size, the adjustment of melt temperatures, or the adjustment of extrusion rates were found necessary to bring the weight within the required specifications.

Mold construction

In order to maximize the output of blow-molded parts per mold cavity, the proper design of the mold cooling system is extremely important. Cooling channels of adequate capacity in the mold block should be installed as close as possible to the mold cavity. These mold channels should be baffled to increase the surface area that the cooling water or fluid is in contact with, thus increasing the heat transfer rate. Coolant flow rates should not be less than 5 gal./min. per mold and a low-pressure coolant supply system of 20 p.s.i. or less should be used. Higher pressure systems allow the use of lower flow rates, but these systems are considerably more difficult to maintain due to the possibility of leakage through porous portions of the mold metal or through joints in segmented molds.

Selection of the correct metal for mold construction is still a controversial question. Obviously, if all conditions were equal (coolant flow rates, material temperatures, cooling line layouts, etc.), the mold constructed with the metal with maximum heat-transfer capability would produce parts at a faster cycle. However, other factors must be taken into consideration; these are mold cost versus number of

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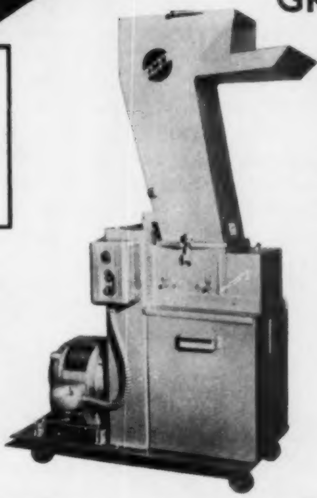

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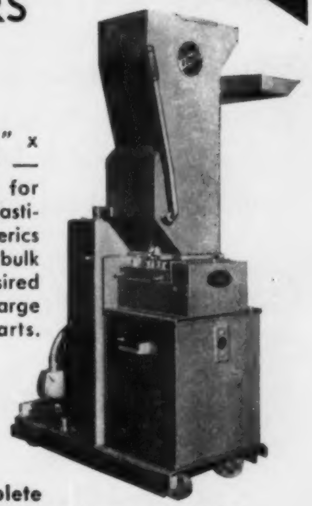

The (IMS) M-4 5⅜" x 8½" throat grinder — designed primarily for vinyl, polyethylene, plastisols and all elastomerics where a fine-free low bulk factor product is desired — large throat for large injection molded parts.

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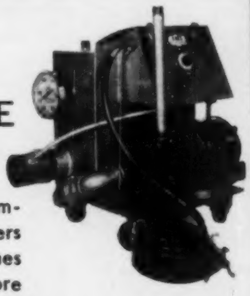

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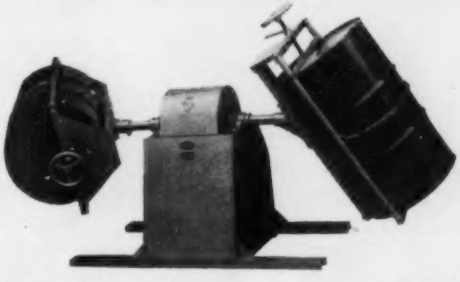

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pieces to be produced and type of part being produced. In each case the molder will have to select the mold material that best suits his particular job.

Among the better mold metals is pressure-cast beryllium copper which has good heat-transfer properties. In addition, pinch-offs can be machined after casting and then hardened to a 45 Rockwell C if required. Cooling zones should be cast-in, as drilling long holes for cooling lines is difficult. One disadvantage of pressure-cast beryllium copper molds is that they are more expensive than molds that are made of aluminum, kirksite, steel, as well as meehanite.

If a soft mold material is used, steel or beryllium copper inserts for the neck ring and bottom pinch-off should be incorporated. In addition to coring in other parts of the mold, both the neck ring and the bottom pinch-off should also be cored for cooling. It is at these points that the greatest amount of heat must be removed due to the greater thickness of material.

In order to obtain a part of good quality with the minimum amount of stress, it is important to use zone control in mold cooling. The zones should be set up in the following way (See Fig. 6 and Figs. 7 and 8, p. 110). Refrigerated water (or an anti-freeze solution) at the lowest temperatures available should pass through the neck ring and bottom pinch-off. Temperature-controlled water in the range of 70 to 120° F. should pass through the mold body proper. This will allow the thicker sections in the neck and pinch-off points to cool at a rate more equivalent to the thinner wall sections in the body of the part. Careful attention to this cooling system balance will result in tighter mold-parting lines, more uniform walls, and lower strain levels in the material. Warm mold body temperatures will generally not increase cooling cycle time, since the limiting factor in any cooling cycle time is the time required to cool the thickest section, usually the pinch-off and neck areas. If these areas are separately zoned for cooling, the metal temperature in these areas will in most cases approach a temperature about that of the cooling medium.

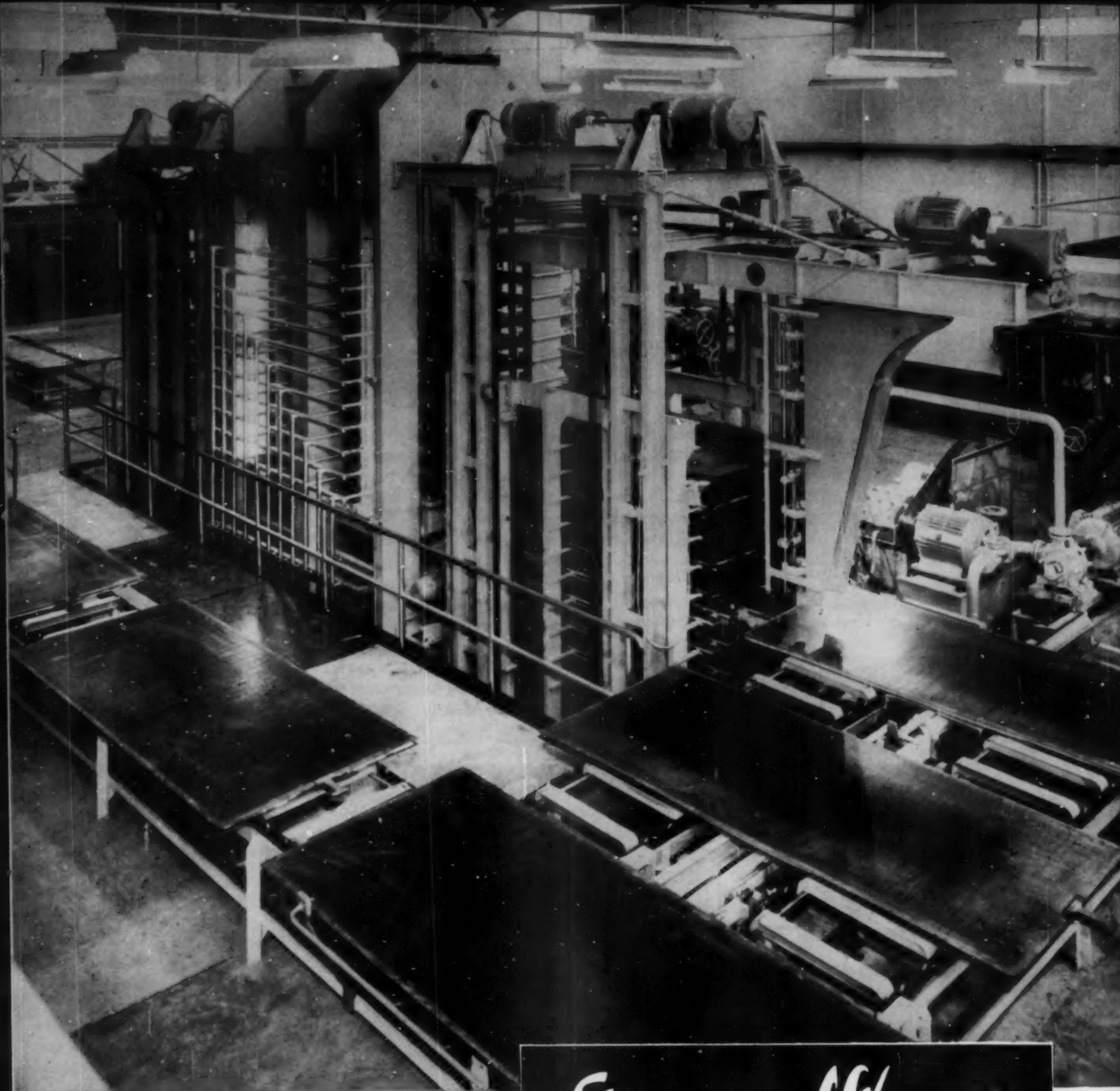
Too low a mold temperature in the pinch-off area can sometimes have a detrimental effect on the extensibility of the hot polymer. When the pinch-off plates close on the parison, the material in contact with the very cold surface of the pinch-off crystallizes and cannot extend outward to the extremities of the object. This causes thin walls at these extremities. Too hot a pinch-off plate is also undesirable since it produces the converse effect, resulting in thin sections in the pinch-off areas and heavier walls at the extremity of the object being molded.

Mold temperature also has an effect upon the mold shrinkage of the part. The lower the mold temperature, the less the shrinkage. The converse is true for increasing the mold temperatures. Mold shrinkage ranges suitable for designing blow molds for linear polyethylene (with a 0.950 to 0.960 density) are as follows: 0.020 to 0.025 in./in. of diameter and length of the object body; 0.045 to 0.050 in./in. of diameter in the neck area transverse to the direction of extrusion; and 0.055 to 0.060 in./in. of length in the neck area which is in line with the direction of extrusion. The above figures for neck shrinkages are based upon measurements taken on blown bottles that utilize the "inside-the-neck" blowing technique.

If the neck is formed by a cooled blowing mandrel and outside pinch-off, the valves that are mentioned above should be decreased by approximately 10 percent.

Quality of surface finish of the object is also dependent upon mold temperature. It will also depend on material temperature, blow pressure, mold surface finish, as well as the mold venting.

Using a colder mold temperature requires a higher blowing pressure to obtain good surface finishes. If the blow air expands the parison at high velocity and pressure, it is extremely important that the mold be properly vented to allow the displaced air in the mold to be released quickly. Failure to do this will cause surface defects due to trapped air on the object at points where there are sharp radii, joint lines between mold segments, and the mold parting lines themselves. Parts with surface depressions are also a problem since



displaced air can become entrapped and not be released unless proper venting is used. A method which has been found most effective for providing adequate venting is as follows:

1. Shim joints between mold segments with 0.003-in. shims, ½-in. wide, in a symmetrical position, 90° apart around the periphery of the segment. If this procedure is not possible, grind grooves that measure ½ in. wide by 0.003 in. deep into the mold cavity on one side of the mold parting line at the joint locations.
2. Put a matted finish on the mold cavity surface by sandblasting with 150 grit sand.
3. Drill 0.015-in. holes in surface depressions. Use a ⅛-in. land and then back-relieve the hole with a ⅛-in. drill.

Blowing techniques

Once a parison of the correct diameter has been obtained and the mold correctly designed for shrinkages, venting, and cooling, there are several other factors to contend with before a commercially acceptable product can be produced on economical cycles.

Blow air. The air used for the expansion of the parison within the mold serves two purposes. The first is to expand the parison tube against the confining mold walls forcing the material to assume the shape of the product desired. The second function of the blow air is to exert pressure on the distended material, now in contact with the mold walls, and force it into the crevices and indentations in the mold surface which serve to produce surface detail on the part, *e.g.* raised lettering, bas-relief designs, etc.

During the parison-expansion phase of the blowing process it is desirable to use as high a volumetric flow rate of air as is available so that the expansion of the parison against the mold walls is accomplished in the minimum amount of time. This will help to assure that the parison expands in a smooth and uniform manner and will contribute to the production of blown objects with uniform walls and good surface definition. The purpose of expanding the parison as rapidly as possible is to form the object in a manner which will allow only the minimum amount of cooling to take place.

In most cases it is desirable to develop the maximum volumetric flow rate into the cavity (at a low linear velocity). This can be done by making the inlet blowing-air orifice as large as possible. In the case of "inside-the-neck blowing" this is sometimes difficult, because of the limits imposed on the size of the orifice which can be used. When small blow-air orifices and other methods should be used to keep linear velocity of the air smooth, with air moving at high linear velocities, the combination can often produce the following undesirable phenomenon in the expansion process. The high-velocity air passing into the parison may create a venturi effect. This venturi effect can create a partial vacuum in the tube causing it to collapse. As the parison expands, the collapsed section will usually form within the blown object a membrane located at the point where the collapsed walls of the tube came into contact with each other. This point often occurs in the neck or shoulder area of bottles as well as a number of similar blown objects.

If the linear velocity of the incoming blow air is very high, the force of this air can actually draw the parison away from the extrusion-head end of the mold. This results in an unblown parison with an upset end which looks like an inverted mushroom. Because a high linear air velocity can cause these undesirable effects it must be carefully regulated. This can be done best by using flow-control valves. For maximum effectiveness, the valves should be placed as close as possible to the outlet or orifice of the blow tube.

In addition to adjusting the volumetric rate of air used for blowing, the pressure of the air must be adjusted to the job at hand to develop the maximum surface detail in the molded object. Blown items of high-density polyethylene having heavy walls can be blown and adequately pressed against the mold walls by using relatively low air pressures of 30 to 40 p.s.i. Low pressure can be used since heavy-wall items cool slowly. This slower cooling process gives the polymer more time at a lower viscosity which allows it to flow easily and

more readily into the crevices and indentations on the mold surface which form the surface detail on the part. Conversely, thin-wall blown objects cool very rapidly. Therefore, the distended plastic on the mold wall will have a relatively high melt viscosity and higher pressures in the range of 50 to 100 p.s.i. will be required to satisfactorily develop the surface details on the object.

In addition to its potential effects on wall thickness, the proper air pressure required will also be influenced by the volume of the blown object. It has been found that items with large volumes of about 1 gal. or more with thin walls about 0.025 to 0.040 in. thick will require higher blow pressure than items of a smaller volumetric capacity. This is probably due to the fact that the expanding material in a large-volume item may have to travel a greater distance during the expansion, or blowing, phase of the process. This would allow more cooling of the material to take place before the material reached the mold surface and the cooler, more viscous material would require a higher pressure to develop the surface detail.

Clamp capacity & closure. In order to assure that the machine has the clamp capacity to handle the object being blown, a quick check on the required clamp force can be made in the following way:

Clamp force = (1.25) (Projected area of object)(blow pressure) Eq. 6

For example, consider an object which has a side panel 5 in. wide by 10 in. high and requires 100 p.s.i. of blow pressure. The clamp force required is (1.25) (50) (100) = 6250 lb. or 3⅛ tons.

This calculation allows a 25% safety factor, which has been found to be satisfactory on most commercial blow-molding machines.

The speed of closure of the mold platens is also important. If the platens are allowed to slam on closure, the parison will shear in the pinch-off areas, thus allowing the blow air to escape. Therefore, it is advisable to use a blow-molding machine which is equipped with a clamping system which will provide a rapid platen traverse stroke up to within a short distance of actual closing, followed by a cushioned, slow, steady application of final mold-closing and clamping pressure. Undercutting pinch-off areas is sometimes used to eliminate the cutting through of the parison due to molds slamming; this, however, usually results in ragged pinch-offs which are difficult to remove.

Conclusion

This paper has presented some of the basic engineering relationships which have been developed from actual laboratory and field experience in the blow molding of plastic products. It is hoped that the use of these sound engineering fundamentals in the design of molds, manifolds, heads, and other components of the blow-molding machine will greatly facilitate the economical production of blow-molded items of high quality. It will also expedite the transition of blow molding from its present state as an art into a well-defined engineering science.—**End**

Designing parts

(*From pp. 114-121*)

since these will also show up clearly on a metallized surface.

Most important, the molder should keep in mind that the parts will have to be placed on racks for handling in the metallizing process. Sometimes significant savings can be made if the runner system is designed so that it may be used to facilitate the racking of parts. This is illustrated in Fig. 7, p. 121. Note how a tab on the runner system was provided for clamping the parts cluster in the metallizing rack. Also notice how double gates were provided on each part so that the individual parts would not fall off the runner and parts cluster when handled in the metallizing process.

Mold layout can also be used to advantage to facilitate the metallizing process and reduce operating costs. Fig. 8, p. 121, shows how one part was located within another so that both could be loaded into the metallizing rack simultaneously, saving both space in the metallizing chamber and time in the racking of the parts. The metallizing of mating parts at the same time is also advisable since there is some variation in the color of the finish from load to load, and mating parts metallized at different times may not match exactly.

In the case of molding mating parts in family molds containing both parts to be metallized and others which will not be metallized, the mold maker should provide sufficient cavities so that enough extra parts which are scheduled for metallizing can be produced to replace losses during metallizing due to rejects. Rejects in the metallizing process generally run between 3 and 5 percent.

Again, because each mold will present new problems, the mold maker should consult with the metallizer about mold design.

Tips for the molder

The molder can also contribute to the successful production of metallized plastic parts. As mentioned before, metallizing the part will accentuate all its faults such as weld lines, mold scratches, and other defects. Therefore, the molder should use care in handling the molded parts prior to metallizing. It is also very important that the molder keep the parts as dust-free as possible prior to delivery to the vacuum metallizer. If parts come from the mold charged with static electricity—making them prone to excessive dust pick-up—they should be destaticized before packing or storage prior to metallizing. To minimize dust and damage to the parts, the molder should place the destaticized parts in plastic bags immediately after molding—at the machine if possible.

Under no circumstances should the parts be placed or packaged in waxed paper or waxed cartons, since the wax which may rub off on the piece can never be completely removed and will seriously interfere with base coating and metallizing. Many rejects may occur before this difficulty is found.

Also, when it is necessary to quench molded parts at the machine, the water used for quenching should be clean and free of impurities such as oils and grease. After quenching, clean water with a suitable detergent should be used to remove any mineral residue spots left by the water on evaporation.

Finally, although mottled materials and clean scrap can be used to make some parts for metallizing, it is not a good idea to use indiscriminately what might be lying around for molding. As was mentioned, material with mold lubricant in it is intolerable in the vacuum metallizing process. By the same token, mold lubricants should never be used in molding any parts destined for metallizing, even if virgin molding material is being used.

These are the general guidelines. But since each product presents problems peculiar to the design of that product, it is strongly recommended that the designer consult his metallizer when he is considering the use of a vacuum-metallized finish for any plastic part.

When proper attention is given to the design details concerning the production of a plastic molded part as outlined in this article, the designer can rest assured his metallizing job will cost him no more than is necessary and will be of a commercially acceptable quality. In helping the metallizer, the designer helps himself, and everyone recognizes a job well done.—**End**

Reinforced polyester

(*From pp. 123-131*)

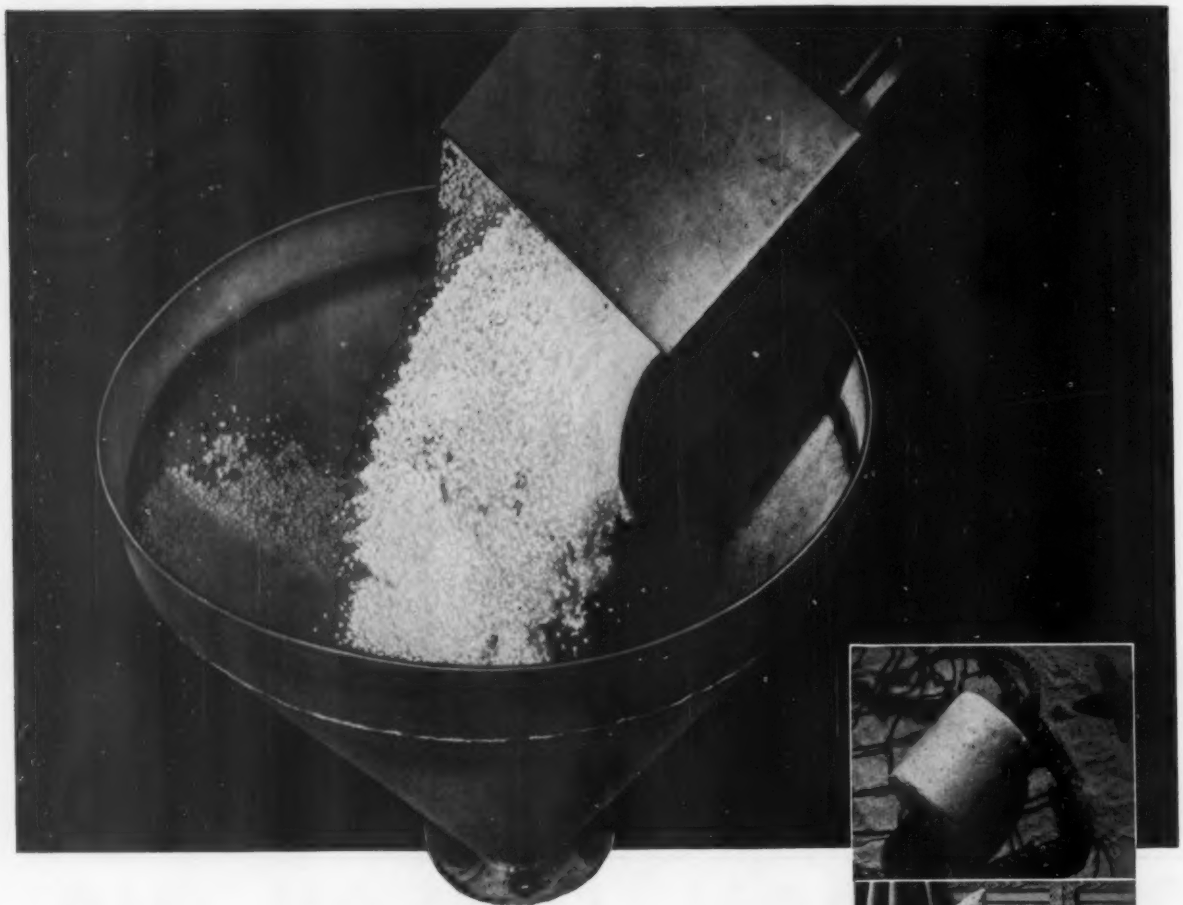
solved. The use of more flexible resins does not fully counteract difficulties associated with the latter.

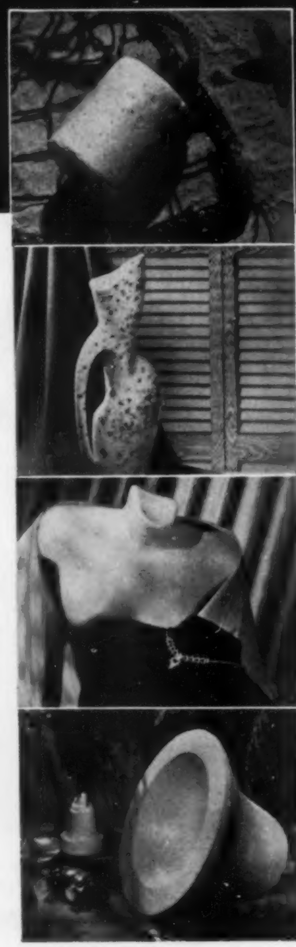
Degradation

The degradation of polyesters by thermal and ultra-violet activation limits their usefulness. While the thermal degradation of polyesters is complex, certain principles concerning routes of degradative processes are now becoming apparent. Little as yet is known about the even more complex degradation of a reinforced polyester system, for here the state of the interface between resin and reinforcement will be all-important. Ritchie (10) has recently reviewed pyrolytic processes in polyesters and has given further results arising from his own work. He has shown, as would be expected, that where a vinyl monomer, in his case methyl α-methacrylate, is polymerized with a polyester (polyethylene fumarate; polyneopentylene fumarate) the thermal degradation commences as a depolymerization of the vinyl chain (11). Initiation of this primary depolymerization is induced at temperatures lower than those necessary to degrade the polyester itself. Depolymerization of the vinyl chain is terminated at the point of cross-linking with the polyester (fumarate) unit.

It is, indeed, of vital importance that such work on thermal degradation be extended to show the effect of the linkage to the reinforcement upon rate and mechanism of thermal degradation. Whether it might be possible to characterize two degradation processes in a reinforced polyester remains to be determined, but the inter-relations between initiation temperatures for degradation of the resin-interface bond and the vinyl-chain-polyester link, and the rates of these respective processes would be of the greatest interest. Additionally, such degradation processes that have been studied at present are homogeneous processes largely independent of any catalytic reactivity of surfaces. In a reinforced polyester, however, surface reactions could conceivably cause a change in mechanism.

Alongside fundamental work on





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thermal degradation, it is necessary to follow photo-initiated breakdown, particularly where oxygen can function as a degradative or crosslinking agent. Although we already have activation energies for degradation of methyl methacrylate of about 8 kcal./mole for overall photo-depolymerization and about 18 kcal./mole for depropagation, it is doubtful whether these figures are valid in a crosslinked polyester system. Since physical states may, in fact, be more important than chemical reactions, considerably more detailed data will have to be produced before degradation reactions can be confidently discussed.

These are problems that must, of course, be examined in considerable detail so that long-term performance can be adequately defined and recorded.

Applications

There is little to be gained by presenting a catalog of applications, interesting as some of these may be, but references to applications in some fields may be of some value. While applications in transportation are of interest, Beyer's recent paper shows how significant is the unavailability of precise information which would enable the design possibilities to be fully assessed (12).

It is, however, probably in architectural applications that lack of knowledge is most apparent. Such applications coming into prominence at present scarcely give a clue to the potential field available for exploitation. While the usage of polyesters expands in various components of buildings, it is their imaginative use in unconventional structures that presents the greater promise and challenge. Problems of production as well as properties appear when, for example, geodesic structures and similar extremely large-scale applications are being considered.

Such problems are, however, similar in every way to those that have had to be solved in order to enable the widespread use of steel framing, pre-stressed concrete, and other modern materials of building. The use of pre-stressed reinforced polyesters (and other resins) would seem to open up tremendous fields in building provided that long-term

properties can be determined and guaranteed.

It must, however, be realized by those who are developing reinforced plastics for building applications that their utilization involves more than mere substitution for conventional materials. New methods of building, new routines for construction, and many problems related to the use of labor having differing levels of skill are all involved and will require joint solution. While the use of reinforced polyesters in services, as finishes and as components of buildings, is of interest, there is little information to be gained here that is of direct value in allowing an extension of use into fields of structural application. With the growth of the term "structural plastics" comes a real responsibility to ensure that load-bearing properties are fully determined. In transportation, chemical plant, materials handling, and marine applications, the same needs are apparent. Will the challenge be met, or left for solution by empirical methods? The latter have ruled too long with many conventional materials. It is surely worth a new approach for a new material.

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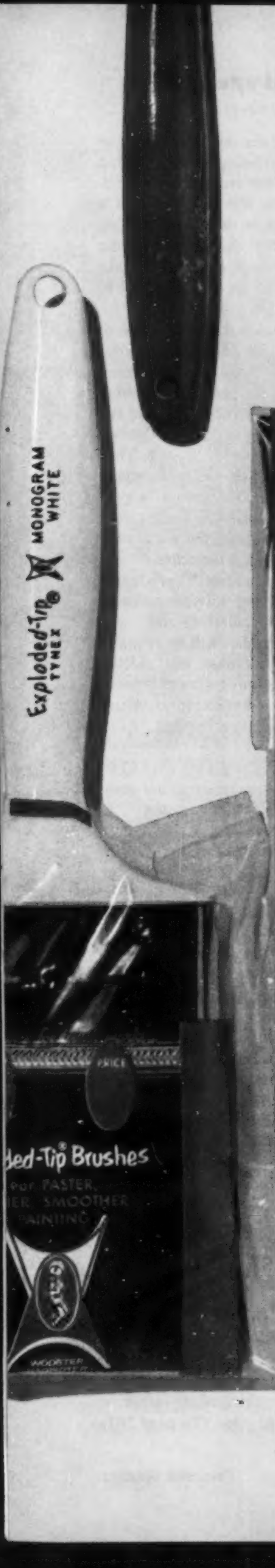

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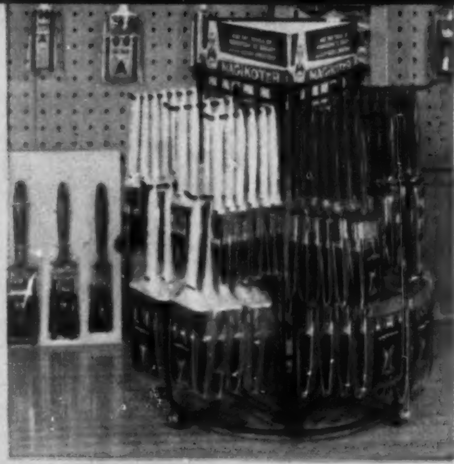

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Infra-red spectrum

(From pp. 132-144)

to the active site on the fifth carbon atom by backbiting of the growing chain as in the second line of Fig. 10, then it is less probable that a second ethylene molecule will attach to the first than that the chain will fold around again and make the transfer of the active radical to the butyl chain just formed.

This is shown in the first line of Fig. 11, p. 138. If the polymerization goes on from this site again, there will be formed a second ethyl side group from the remains of the first butyl side group. This is shown in the second line of Fig. 11. Thus the formation of twice as many ethyl as butyl side groups is possible, and if only the smallest ring transfer takes place, there will only be butyl and ethyl branches.

The mechanism producing branching during polymerization is still rather speculative, and more quantitative studies will be required to fully substantiate the mechanisms. The determination of branching by infra-red spectrophotometry appears to be quite feasible.

Oxidation

Another group of structural components in polyethylene is that produced by oxidative degradation (6). These constituents are of considerable economic importance since they affect the service life of the polymer. Much has been discovered about the mechanism of oxidation of polyethylene, but until recently the knowledge was mainly determined from studies of the degradation of model compounds (34-38). Now it is possible, using infrared spectroscopy, to study the polymer itself, whereas previously the difficulty of putting it into solution for analysis made classical methods impractical. The fortunate fact is that it is possible to record the actual oxidation process of the intact polymer as it degrades right in the spectrometer (39).

Consider, then, the changes in the spectrum of a sheet of the polymer as it is heated to the melting point in an oxygen or air atmosphere in a heated cell in the infrared spectrometer. The region of the spectrum between 3250 and 3750 $cm.^{-1}$ and the changes are shown in Fig. 12, p. 141. On **(To page 201)**

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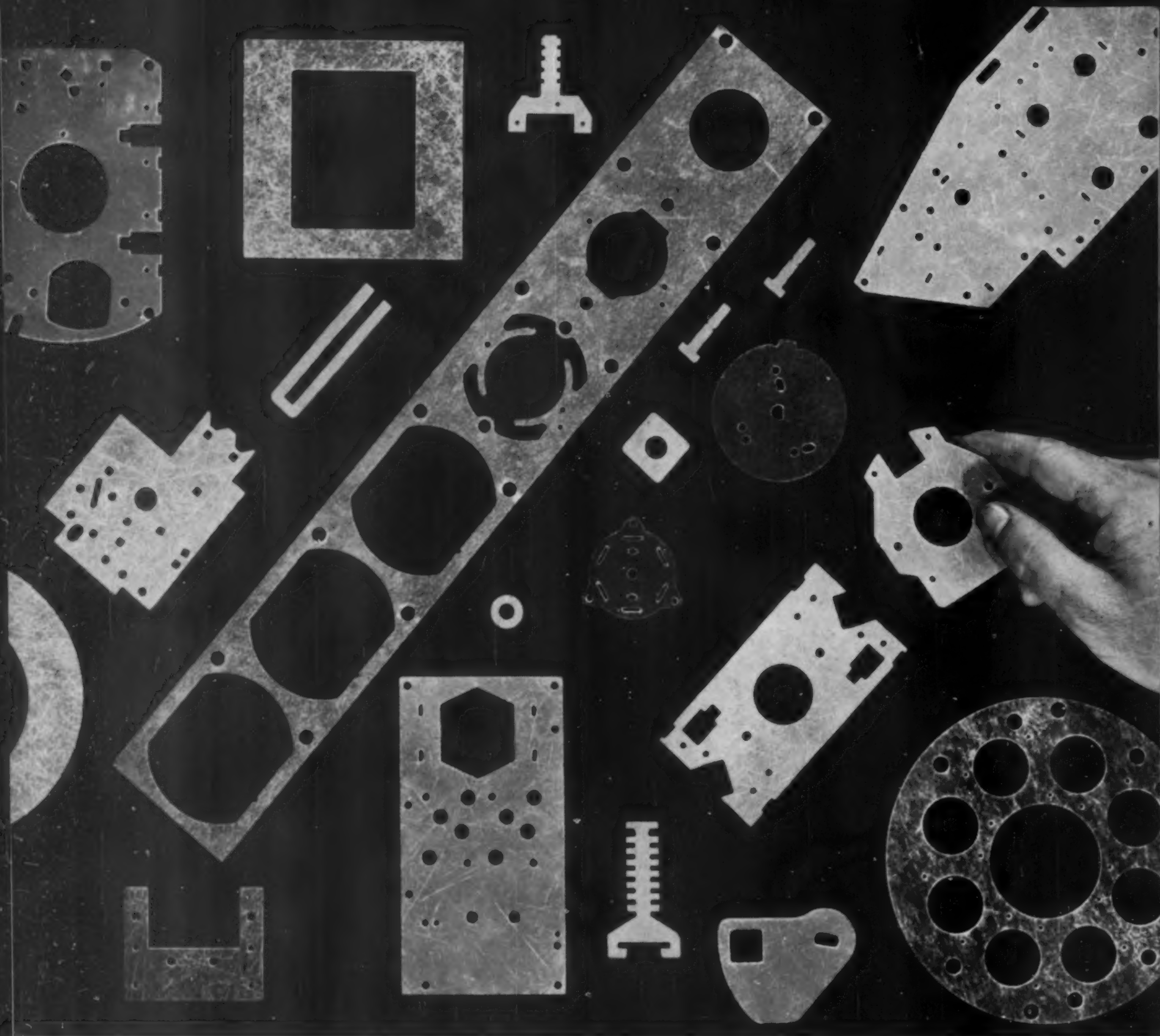
the left is the effect observed in Marlex 50, while on the right is the effect observed in Bakelite DYNK. Neither sample contains an anti-oxidant. The band at 3620 $cm.^{-1}$ is a combination band from lower frequency CH vibrations; this stays relatively constant during the oxidation and can be used as a reference of intensity. The other two bands, however, do not belong to the pure hydrocarbon polymer. The weak OH band at 3380 $cm.^{-1}$ is found in almost all commercial polyethylene samples. This OH band increases slowly during the oxidation process. The other band in the region is not present in the polymer as commercially produced and appears only during the oxidation process. This band falls at 3555 $cm.^{-1}$ and is assigned to the hydroperoxide (OOH) group. As can be seen from Fig. 12, the 3555 $cm.^{-1}$ band increases steadily during the first 6 to 8 hr. under the conditions of the experiment, then levels off to a more or less constant value. On cooling the band decreases in intensity, and it also decreases in intensity if the oxygen supply is cut off, as by substituting a nitrogen atmosphere. This behavior is the same in both polymers.

The fact that the intensity of the band due to hydroperoxide diminishes in an inert atmosphere indicates that this group is a precursor for other oxygenated end products of degradation. The OH is evidently an end product, since it does not diminish in an inert atmosphere. This direct demonstration of the presence of a hydroperoxide precursor in the oxidation of polyethylene supports the earlier theories, based on model compounds, which stated that the hydroperoxide was the first step in a long line of autocatalytic processes (35-37). The proposed chemistry (40) of this reaction, in its simplest form, is shown in Fig. 13, p. 141. The first step is activation of the polymer molecule either thermally or by a photon, giving an active radical denoted by $R^{\cdot}$ and atomic hydrogen $H+$. The active radical ($R^{\cdot}$) then combines with oxygen from the atmosphere and forms the hydroperoxide radical $ROO^{\cdot}$. This radical reacts with a hydrogen atom making the hydroperoxide group ROOH and another reactive radical ($R^{\cdot}$) in the system. This radical



can then go on to fix more oxygen and keep the process going. The fact that a second radical is formed from the first makes the process an autocatalytic, or chain, reaction. The fourth step in Fig. 13 indicates how the hydroperoxide group can break up to form the end products of the whole process. More will be said about these later. The two equations at the bottom of Fig. 13 indicate how the action of an antioxidant (HA) may terminate the chain of events, thereby preventing further oxidation from the first radical.

Turning next to the carbonyl region shown in Fig. 14, p. 141, we see a large number of bands that increase in intensity with exposure time during the oxidation process. Each one of these bands can be assigned to the characteristic type of C=O stretching vibration since this is a region where a one-to-one correspondence between absorption band and molecular grouping is common. The various types of carbonyl groups are indicated in the figure. The identification is accomplished by comparison with many other model compounds having the particular carbonyl group present. Starting at low frequency and going to higher, we see first at 1685 cm.$^{-1}$ a band due to an alpha-beta unsaturated ketone. At 1705 cm.$^{-1}$ there is a very strong band due to acid groups, COOH. At 1715 cm.$^{-1}$ there is a band even stronger due to the ketone structure, and at 1728 cm.$^{-1}$ the strong component is due to the aldehyde group. A much weaker band at 1740 cm.$^{-1}$ is associated with the ester group. There are two other distinct band heads at 1785 and 1763 cm.$^{-1}$ which also continue to increase during heating but diminish upon subsequent cooling. Their location at this relatively high frequency in the carbonyl region indicates the formation of unusual carbonyl structures. The bands at 1785 cm.$^{-1}$ have been attributed to peracids, R(C=O)OOH, which may act as oxidizing agents, and the bands at 1763 cm.$^{-1}$ have been tentatively assigned to peresters, R(C=O) OOR. The acid, ketone, and aldehyde groups are most numerous for the conditions of this experiment.

The intensity of the band at 1640 cm.$^{-1}$, due to unsaturated groups, does not change appreciably during

oxidation showing that the total unsaturation does not change substantially in oxidation even though the type of unsaturation does change. For example, the distribution of olefinic groups is different for heat-oxidized and photo-oxidized samples, as shown in Fig. 15, p. 142. The contours of the carbonyl vibration bands are also distinctly different in the photo-oxidized and heat-oxidized sample. Actually, the same components are present in both spectra, but the concentration ratios are different.

The general depression of the background from 1400 to 800 $cm.^{-1}$, together with the appearance of a weak band at 1075 $cm.^{-1}$, can be assigned to ether groups and alcoholic C-OH linkages which are among the oxidation products. A possible mechanism for the formation of these other end products of the oxidation process are shown in Fig. 16, p. 142. Here the hydroperoxide group (ROOH), formed as shown in Fig. 13, breaks down to $RO^{\cdot}$ and an $OH^{\cdot}$. The $RO^{\cdot}$ can break down directly by an internal dehydrogenation into the unsaturated ketone discussed before (right side reaction). The center reaction shows the dissociation of the $RO^{\cdot}$ into an aldehyde. Further oxidation of this aldehyde would yield an acid. The reaction of this acid with an alcohol (see Fig. 13, steps 3 and 4, $RO\cdot + H^+ \rightarrow ROH$) would yield the ester. The left side reaction in Fig. 16 depicts the aldehyde, also formed by the dissociation of the $RO^{\cdot}$ radical, oxidizing to the intermediate radical which could combine with either $R^{\cdot}$ or H^+ forming the perester and peracid.

These reactions account for the presence of infra-red-detectable carbonyl-containing oxidation products, but it is obvious that they are not the only reactions possible.

Figure 17, p. 142, shows the spectrum of a mildly oxidized sample and the structure that is revealed when an expanded scale is used. At the top of the figure is shown the ordinary spectrum which for this thin specimen and weak oxidation shows very little of the carbonyl groups. At the bottom is shown the spectrum of the same specimen with a 10$\times$ expansion of the ordinate. Thus the scale is such that the absorption from 90 to

100% is blown up full scale. It is evident that many of the various C=O bands are present very early in the oxidation process.

Most of the chemical equations of Figs. 13 and 16 show that the process of degradation occurs at a carbon atom alpha to an activating group such as C=C or C=O. The presence of the 1685 cm.$^{-1}$ absorption during oxidation due to the alpha-beta unsaturated ketone group along with the decrease in the extinction coefficient of the CH_2 band near 2800 cm.$^{-1}$ strongly supports the theory that the alpha carbon is quite susceptible to oxygen attack after autocatalytic oxidation has begun. A possible mechanism for the formation of this particular group is summarized in Fig. 18, p. 144. At the top the alpha carbon next to the unsaturated bond in the polymer molecule is attacked preferentially giving a decrease in the CH_2 content of the sample. With O_2 the hydroperoxide is formed, which then degrades to the unsaturated ketone and H_2O.

A mechanism of formation of the long wavelength ether absorption is also shown by the equation at the bottom in Fig. 18. The possible mechanism represented here, ends up with a crosslink between two polymer molecules, and this may account for some of the decrease in solubility of the material.

Infra-red absorption due to still another kind of oxidation product is shown in Fig. 19, p. 144, where a ketone group in a long chain hydrocarbon gives a band at 1415 cm.$^{-1}$ This band occurs in the later stages of oxidation and is of moderate intensity. It shows that the unsaturated C=C double bond is not the only activation group. Other structural anomalies, such as phenyl groups, carbonyl groups, and carboxyl groups, may also initiate oxidation.

Figure 20, p. 144, shows evidence which confirms that the olefinic groups present in most commercial polyethylene are changed during oxidation. Here the region of the spectrum near 1000 cm.$^{-1}$ is shown in detail, and the various absorption bands are identified in the intact polymer at the left. Although the total unsaturation does not change substantially during oxidation, the relative concentration of the various types does. (6). And

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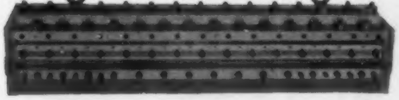

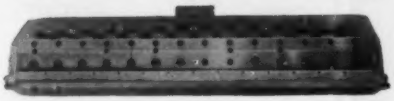

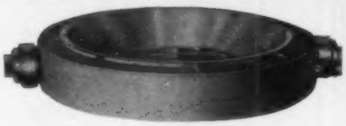

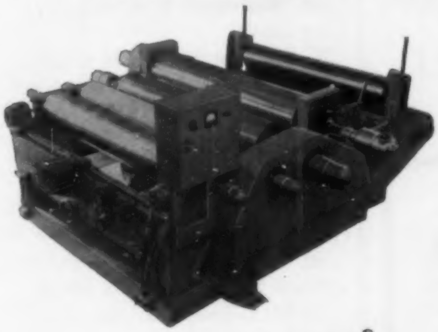

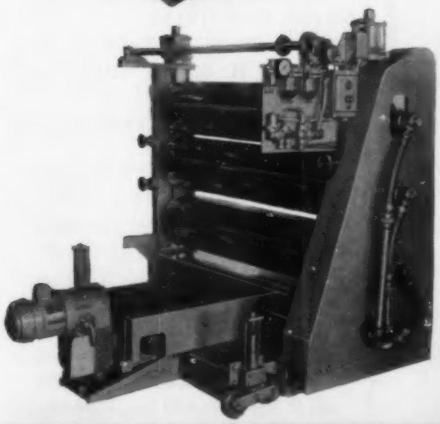

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for heat oxidation, the pendant groups decrease and both of the other types increase in number. In the case of the photo-oxidation, the pendant midchain group is almost eliminated, with a corresponding increase in the terminal unsaturation. This may mean that chain scission is the most important effect of photo-degradation, but this process has not as yet been studied in great detail.

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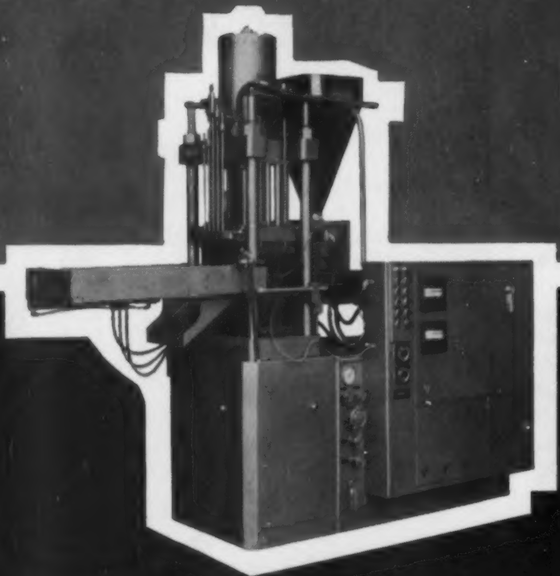

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THE PLASTISCOPE*

News and interpretations of the news

By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 39)*

March 1961

Plastics dominate Housewares Show

The 34th NHMA National Housewares Exhibit which was held in the new McCormick Place exhibition center in Chicago in February provided ample evidence that the $3-billion housewares industry has developed a built-in sensitivity to the more obvious trends in materials and processing technology.

A tour of the more than 900 exhibits and 1600 booths showed a record number of plastics products —and probably this represents a record volume usage.

New materials, new techniques

Many of the new products exhibited at the show were appropriately enough the results of emphasis on some of the more recent plastics developments. Observers pointed to the following trends: supplementing conventional processing techniques with such innovations as blow molding and thermoforming to achieve greater flexibility in design; emphasis on molded-in foil decorating techniques for melamine and urea tableware and other goods; more applications based on the unique properties of foamed plastics, notably expandable styrene; and increasing use of some of the newer plastics, such as polypropylene, linear polyethylene, impact styrene, and styrene-acrylonitrile copolymers, to build characteristics of toughness, longer wear, and greater resistance to heat into the finished product. The end result: a very noticeable up-grading in the quality of plastics housewares being produced—both in terms of style and function.

Blow molding gets a big play

For a technique that made only a spot appearance at last year's housewares show, blow molding came on strong in this year's line-up. Some of the new blow molded items on display included: a "Swedish Modern" watering can with molded-in spout and handle, striking "milk glass" products with hobnail surface treatment, and salt and pepper cellars simultaneously produced in a single blowing operation, all by the same firm; bud vases, containers of all types, and cookie jars; and even life-size blown flamingoes for use as lawn decorations. The conclusion is an obvious one: if it's hollow and if it's housewares, chances are that blow molding can be considered for the job.

Refinements in foil decorating

Refinements in surface decorating techniques were everywhere apparent at the NHMA show. This applied not only to melamine tableware, up-graded through introduction of numerous new and interesting patterns, but also to the general run of housewares. Included among the foil-decorated items were a three-compartment electrical baby food warmer that was molded of melamine.

Many new products from foam

The flood of products molded of expandable styrene shown in the exhibits (mirroring the burgeoning of foam applications in other fields) indicates that this will become a major material of use for housewares producers. Represented in number were firms offering a variety of picnic chests and beverage coolers molded of expandable styrene; also shown were flower pots in a range of sizes, as well as a new family of "Fun-a-Float" surfboard and flotation type swimming toys made of the same styrene foam material and running up to 18 by 60 in. in size.

In addition, several manufacturers displayed picnic jugs constructed with inner and outer bodies of linear PE having a layer of insulating material, e.g., plastic foam or fibrous glass between them.

Added interest in polypropylene

What about polypropylene? Indications are that although many housewares manufacturers are interested in the material and are evaluating it for possible use in their lines, its greatest housewares impact to date has been—as in other fields—in specialized types of products (vaporizers, small appliances, etc.) in which its specialized properties can be used to advantage.

Molded polypropylene items on exhibit included: vacuum bottles; attractive canister sets, bread boxes and cake cover sets; modular stacking shelves; and injection-molded dinnerware.

Tumblers a specialty line

Tumblers of all types have become a specialty among many of the companies exhibiting at the housewares show. A number of firms are producing transparent plastic tumblers of various designs, using heat resistant styrene and styrene-acrylonitrile combinations in most instances. Such tumblers are extremely break resistant and will come through automatic dishwashers without damage. More complete details on a unique application in this field and its possible effect on the housewares industry will appear in a subsequent issue of MODERN PLASTICS.

Decoration of plastic tumblers appears to have reached a new high at the NHMA show. A wide choice of decorative treatments is offered, with a great many patterns and colors from which to choose. A number of molders are now offering novelty tumblers (clowns, Santa Claus, etc.) on which molded lenticular eyes are mounted, giving the appearance of eye movement as the tumbler is viewed from different angles. These are of special in-

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THE PLASTISCOPE

(From page 212)

terest to the younger set. Also on display at the show:

Reinforced plastics in juvenile furniture. Shown was a high-chair with a molded glass-polyester seat unit and foot rest and high-impact removable tray. The unit is so designed that as the child grows, the legs of the chair may be shortened to produce a low-chair or juvenile chair as required.

Urethane foam in a 2-in.-thick mattress of a new folding bed with tubular aluminum frame. The mattress is covered with a zippered two-tone gray ticking. Also shown were a new line of station wagon pads of polyether-type foam.

Why is polystyrene growing?

One example of why packaging is becoming the largest outlet for polystyrene molding material is the following notice from J-E Plastics Mfg. Corp., Yonkers, N. Y.

Two large forming machines, each capable of producing 60,000 plastic containers for fresh and frozen foods in a 20-hr. day, have been added to the production facilities of the Food Container Division. The equipment was built by Emhart Mfg. Co. Two other large forming machines with multiple cavity molds will be installed within the next few weeks. J-E has been producing pressure formed oriented styrene food containers since early 1960, and has invested more than $750,000 in machinery, research, and engineering.

Herbert Magnes, president of J-E, also announced that final web guide controls and other specially developed electronic equipment have been installed on the flexographic press which produces multicolor printing at high speed on the plastic roll with remarkably accurate register. He also announced the development of entirely new heat sealing equipment to provide a curled-over seal which remains resilient and non-brittle even during deep freezing.

J-E containers, already in use for dried fruit, seafood, meat and dairy products, and confectionery, are also finding large volume markets in automatic food canteens and for institutional use in schools, hospitals, and industrial cafeterias. These containers can be filled at boiling temperatures and immediately frozen at −80° F. in dry freezing and −350° F. in liquid freezing.

Mr. Magnes claims that his is the only completely integrated operation of its kind in the country. J-E produces the container, the lid, and the graphics for brand identification. Containers are round, rectangular, and square, and are produced in a wide variety of sizes with snap-in and snap-over lids as well as with heat seals. The company has completely redesigned its round plastic lid used with paper, molded plastic and other conventional containers as well as with J-E formed tubs. It is claimed that this lid, recessed for stacking, can be used on any high speed automatic equipment.

PE for submarine cable

A new low-loss electrical grade polyethylene compound for primary insulation of transoceanic submarine telephone cable systems has been developed by Union Carbide Plastics Company. Designated Bakelite DFDA-0173 Natural, the material is being evaluated for high voltage applications and other critical uses. DFDA-0173 is characterized as an unmodified, high-molecular-weight PE compound containing only antioxidant, especially prepared in a contamination-free atmosphere to eliminate the danger of breakdown of insulating properties. Resistance to stress cracking has also been considerably improved even though no butyl rubber is used.

Density of the new material is 0.923. The melt index is less than 0.1 but extrudability is good at a compound temperature to 520° F.

Vinyl chloride in construction

In October and December of 1960, MODERN PLASTICS printed two significant articles on the future of vinyl plastics pertaining to the construction industry. As indicated therein, there has been a plethora of printed material on the dawn of this market as a potential user of billions of pounds of plastics but very little information has been forthcoming on actual products that can be bought even if the potential buyer is on the search for such products.

The vinyl industry is doing something about this situation by actually producing and marketing such products. Several such items that are being vigorously promoted by B. F. Goodrich Chemicals Co. have come to attention within the last month. They are:

A flexible vinyl sealer strip used in weatherstripping for doorways made from Geon resin by Davidson Products Co., Seattle, Wash., who extrude the strip which is used by Sun Screen Products of Spokane in an aluminum weatherstripped door stop that has already reached a volume of a little more than one million feet.

Another item is a vinyl coated nylon air-supported structure built for the U. S. Atomic Energy Commission's Atoms-for-Peace exhibit in Argentina. The 300- by 126-ft. structure is 65 ft. high. It was built by Birdair Structures of Buffalo. The two layers of nylon were coated by Farrington Texol Corp., Walpole, Mass. According to the company, the structure can withstand 70 m.p.h. steady winds. The fabric is colored white and is waterproof and fireproof.

Another item is vinyl waterproof slip joints used to connect vinyl electrical conduit in the new 3-mile bridge at Pensacola, Fla. They are inserted in each conduit between every concrete section to allow for expansion and contraction of the bridge while maintaining a seal. The plastics conduit was manufactured by Dixie Plastics, New Orleans, La.

Another item is vacuum formed high-impact rigid vinyl shutters made from sheet produced by Seiberling Rubber. The manufacturer was Columbia Broadcasting System, New York. The shutters are made to look like old-fashioned wooden shutters. A distributor is needed to promote this product. A big market for this product is only waiting for some enterprising individual who has enough imagination to pro-

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(From page 214)

mote its possibilities. More details are available from the December MODERN PLASTICS article, p. 86.

Poly-Skin from Flex-O-Film

A new treated polyethylene film said to have exceptionally high clarity has been announced by the Flex-O-Film Div. of Flex-O-Glass Inc., Chicago, Ill. Called Poly-Skin, the new product is available as clear cast film only with the proper paper board and printing inks, no coating or perforating are necessary for skin packaging, the firm states. The addition of the new film rounds out the company's packaging film line, which now includes over-wrap, bread-wrap, and industrial films, flexible and rigid vinyl in gages up to 0.030, and butyrate from 0.001 to 0.125 gage in widths up to 72 inches.

Nylon for food handling

Du Pont's major Zytel nylon resins have been established as safe for food handling and processing applications by recent Food & Drug Administration regulations, according to Henry M. Cadot, product manager for Zytel in Du Pont's Polychemicals Department. The FDA ruling paves the way for dozens of new applications for Zytel, many of which are already in the development stages. Zytel is being used now under a 1-year extension from the FDA exempting the resin from provisions of the 1958 Food Additives Amendment.

Of the principal food handling applications, a major use has been in food and soft drink dispensing apparatus. Valves on cola, fruit juice, coffee, and soup dispensers have been replacing metal with Zytel for more than five years. Another use is a no-drip, self-closing faucet on a coffee urn which not only reacts quickly to finger control, but has also stood up well under heat and abrasion.

The FDA ruling on nylon-6/6 and -6/10 nylon resins is expected to have considerable impact in the dairy equipment field. Already field tested as components for milking machines and in vacuum and conveying lines in dairies, nylon resin has the advantage of being heat sterilizable. Milking machine fittings are now made of metal alloys to withstand the frequent dismantling, brushing, corrosive cleaning solutions, and steam sterilization required in milk processing.

Zytel 101-NC 10 had previously met the requirements of the Meat Inspection Div. of the Dept. of Agriculture for such uses as scraper blades in sausage-making machinery and in meat hooks or hanger straps. The material is expected to find similar applications in the canning industry in paddles, stirrers, and mixer bearings.

Vinyl resin blend for records

The availability of a new material for the molding of phonograph records has been announced by Rubber Corp. of America, Hicksville, N. Y. The product, designated Rucoblend, is a blend of vinyl homopolymer and copolymer resins, and is designed primarily for the small independent record pressing firm.

Under a package plan developed by Rubber Corp., the custom record presser purchases both Rucoblend and a compounding machine. This makes it possible for him to mix raw materials into record molding compound right in his own shop instead of purchasing extruded "biscuits" of other material.

The new processing method is said to produce a phonograph record of higher quality at no additional cost over previous methods. This high quality is obtained by the elimination of multiple heating of the molding compound which often lowers the properties of the material. In-plant processing by which the custom presser can mix only as much compound as he needs also prevents possible contamination of the molding compound during shipment or storage.

The primary market for Rucoblend is about 130 custom record pressers who serve approximately 1800 record companies in this country. Reportedly, several large record companies, who mold records for their own label, have shown interest in the new material.

Vinyl flooring

A. F. Thomas, sales manager of Goodyear Films & Flooring division, says he anticipates an increase of at least 17% this year over the previous high for his company's flooring products. He bases his optimistic forecast in several factors, including an improved business picture, consumer trends, and the company's product diversification and expansion.

"Economists predict new home construction and remodeling—lifeblood of the flooring industry—will be up 5 to 6% over 1960, or slightly under the peak of 1959." Mr. Thomas pointed out that the company is introducing five new styles in residential and light commercial flooring and counter topping at the market and plans addition of a new "on-grade" line later in the year.

He also said the multi-million-dollar expansion program, announced late in 1959 and completed last year, provides the production capacity necessary to meet the projected volume increase.

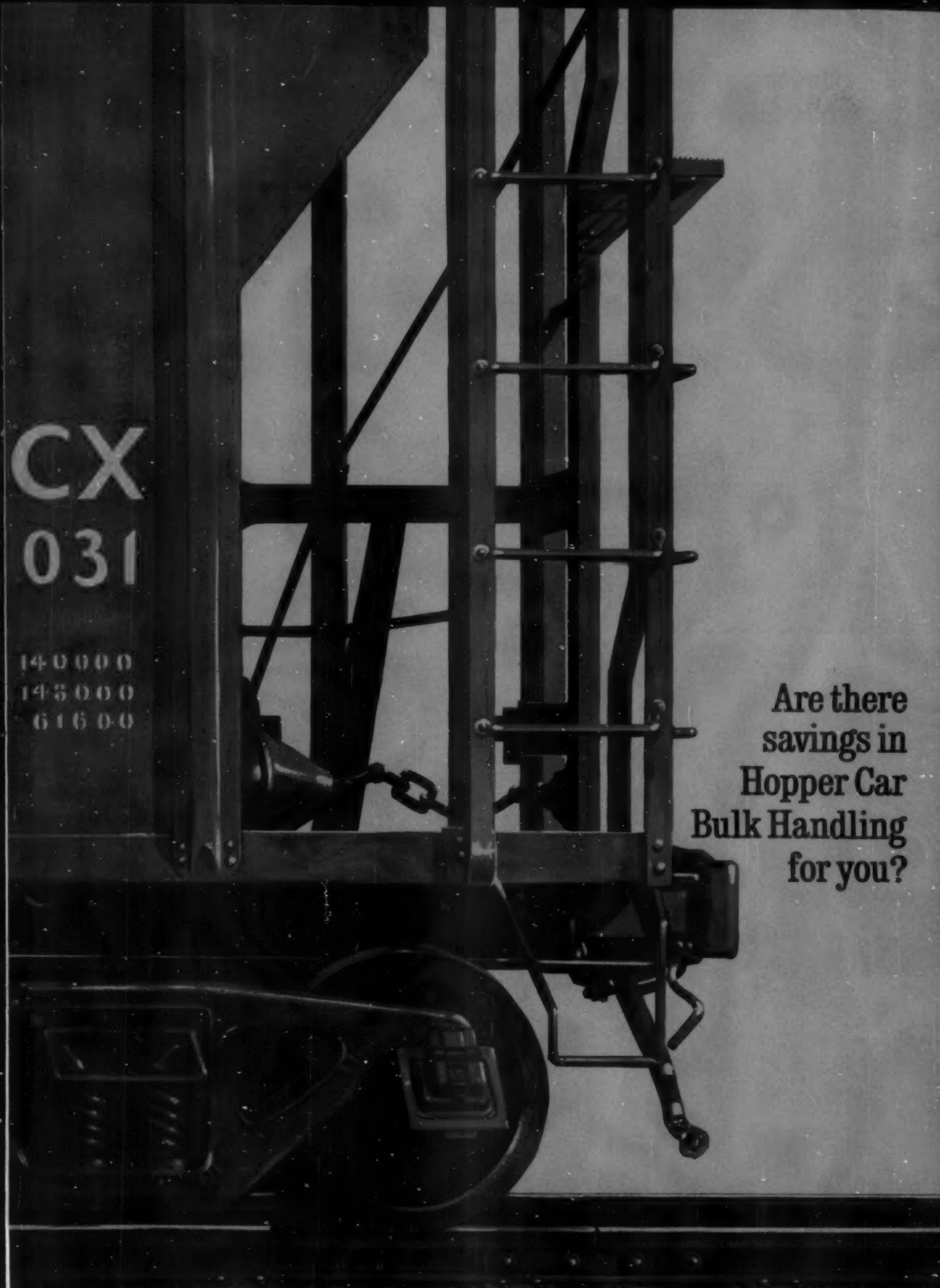
Ed. note: Vinyl chloride resin used for flooring was estimated at 155 million lb. in 1959 and somewhere around 160 million lb. is estimated for 1960.

Low-density PE for frozen food packaging

A new low-density polyethylene formulation is being marketed by Eastman. The material is designed for extrusion into film which is said to have excellent properties for frozen food packaging, particularly the IQF (individually quick frozen) foods. There has been much talk about polyethylene for this purpose, but volume use is still small.

Films extruded from this low-melt-index resin are characterized by high impact strength at low temperatures, extraordinary tear strength, good optical clarity, and excellent slip and antiblocking properties, the company states. In addition to their use for frozen food packaging, these films are equally well suited for other film-packaging applications.

The resin, Tenite PE 161M Natural, has a nominal **(To page 220)**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As a plastics user, you must answer certain preliminary questions: • Are your quantity requirements sufficient to warrant bulk handling? • Can your product mix be standardized, inventory simplified? • Are your present facilities readily adaptable to economical bulk handling?

Let us help you investigate bulk handling. Your Monsanto representative has a new system for evaluating the savings potential in bulk handling for you. It's based on principles derived from many actual installations engineered by Monsanto. Ask him about it today. No obligation, of course.

MONSANTO BRINGS OUT THE BEST IN PLASTICS—a broad range of materials for Home, Industry and Defense. LUSTREX®, LUSTRAN T.M. styrene plastics • SAFLEX® vinyl butyral • RESINOX® phenolic • Polyethylene • ULTRON® vinyl film • RESIMENE® melamine • OPALON® vinyl chloride • SCRIPTITE® paper resins • STYMER® sizes • VUEPAK® cellulose acetate • RESLOOM® textile finishes • LYTRON® synthetic resin • SANTOFOME® foamed styrene

Monsanto Chemical Company, Plastics Division, Springfield 2, Mass.

MONSANTO

Monsanto

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density of 0.923 and a melt index of 0.7. Film can be produced by either the flat film or blown film methods of extrusion.

Non-phthalate plasticizers

Pilot plant quantities of 2,2,4-trimethylpentanediol monoisobutyrate are now available from Eastman Chemicals Products Inc., subsidiary of Eastman Kodak Company. Tradenamed Texanol, the new chemical is expected to find primary use in the production of non-phthalate based plasticizers.

Texanol combines readily with monobasic or dibasic acids to form compounds that show unusual thermal stability. Preliminary studies by Eastman indicate that the adipate and benzoate esters are excellent primary plasticizers for polyvinyl chloride and cellulose resins. Of several other esters studied the tallate and epoxidized tallate derivatives perform well as secondary plasticizers in vinyl chloride and plastisol formulations.

Other potential applications for Texanol include its use in the preparation of polyesters and reaction with isocyanates for synthesis of polyurethane.

Polyester price reduction

A 15% reduction in the selling price of general purpose, rigid, resilient, and molding polyester resins (CoRezyn) has been announced by Commercial Resins Corp., St. Paul, Minn. This comes to a price cut of 5¢ per pound. Orthophthalic resins are now 26¢/lb. in bulk, 28¢ in 40 drum truckloads, 29½¢ in 1 to 9 drum lots. Isophthalic resins now sell at 27¢, 29¢, and 30½¢ in the same respective quantities.

Heat-resistant phenolic laminate

In what could be a highly significant development, Westinghouse has announced glass-fabric-reinforced phenolic laminates that compare favorably in heat resistance with laminates incorporating silicone. It has long been believed that the only drawback to widespread use of high-heat resistant laminates was the cost of the silicone type. This may now be changed. The properties of the relatively low-cost Westinghouse material are said to include higher flexural strength at all temperatures than laminates with a silicone binder. In weight loss and erosion tests, the new phenolic laminates closely approach glass-silicone laminate and are claimed to far exceed glass-melamine and glass-polyester laminates. A related quartz-phenolic laminate has three times the erosion resistance of the glass-phenolic laminate but a somewhat lower flexural strength.

The materials can be used to particular advantage in applications requiring a combination of stability against thermal shock, high strength-to-weight ratio, low thermal conductivity, and high strength retention at up to 500° F. for relatively long periods. The new laminates have already been used as air frame structural parts, rocket nozzle liners, heat shields for re-entering nose cones, slot wedges, turbogenerator slip rings, arc chutes, panel boards, etc.

The most significant step in development of heat-resistant phenolic laminates was in connection with postcuring cycles. Typically, phenolic resins form blisters and delaminate during postcure, especially in constructions of over ⅛ in. thick. This deterioration is attributed to the pressure developed by the gaseous degradation products and to the lack of escape routes. The degradation products also act to weaken interlaminar bonding strength through chemical action. The phenolic resin for the improved laminates was designed to minimize formation of destructive components at postcuring temperatures.

The laminates are made by standard methods, using No. 181-weave glass fabric with A-1100 finish. Resin content is 30 to 35 percent.

Fire-resistant urethanes

The Applied Plastics Div. of Hexcel Products Inc., El Segundo, Calif., has introduced a new fire-resistant foam which supplements the company's production of foams, adhesives, coatings, hardening systems for epoxy resins, as well as other resinous materials.

The new product, Hexcel 1460 Urethane Rigid Foam System, displays approximately the same mechanical, insulation, and chemical resistance properties as Hexcel's other major foam systems; but in addition it will not support combustion. It can be obtained in sprayable or pour-in-place formulations. It has a standard nominal density of 2 lb./cu. ft., but other densities are available in quantities over 5000 pounds.

Another self-extinguishing rigid urethane foam has been introduced by Toyad Corp., Latrobe, Pa. manufacturer of foamed products for over 20 years. Designated Chemfoam RSF, it is manufactured from Hooker Chemical Corp.'s Hetrofoam materials in 2- and 6-lb./cu. ft. densities. Intermediate densities can be custom made upon request.

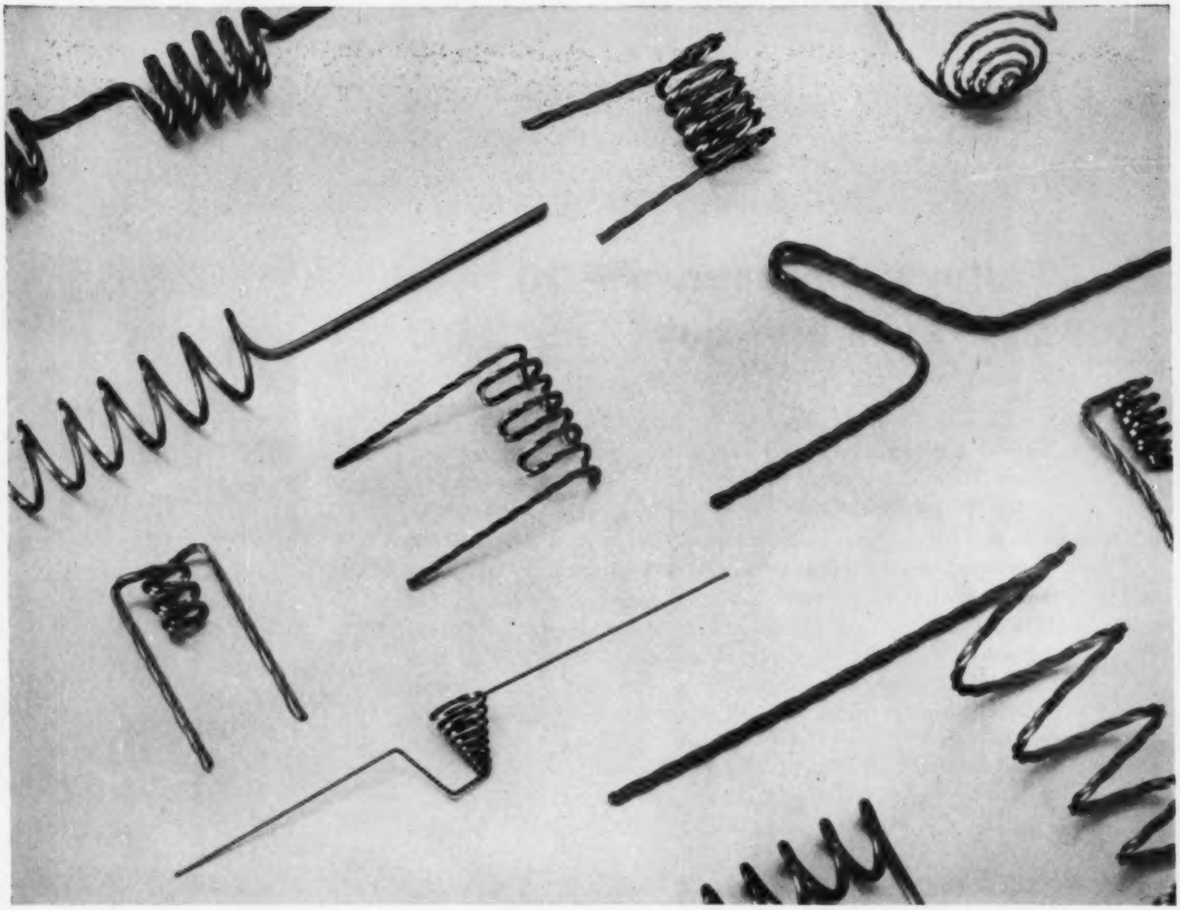
Fire resistant vinyl-coated nylon

Super Vinyl-coated nylon produced by Farrington Texol Corp. under the designation Super Tuff-Tarp has been approved by the Factory Mutual Engineering Div. of the Associated Factory Mutual Fire Insurance Companies for any purpose where a fire resistive fabric is considered desirable.

Tuff-Tarp was used in the construction of the air-supported Penta-Dome at Andrews Air Force Base, Suitland, Md. It has since found wide acceptance for other air-supported structures, both in the U. S. and in Mexico, and for missile shelters and coverings.

Flame retardant for polyether foams

A new material, Niax Flame Retardant A, that adds flame-retardant properties to rigid polyether urethane foams is now commercially available from Union Carbide Chemicals Co. The material is a free flowing powder that is dispersed in the resin side of the foam formulation. The components of the foam formulations are then processed in the usual manner. Niax Flame Retardant A is said to make only minor changes in the properties of foams **(To page 224)**



Fellows molds over 400 "toys for girls and boys" at LIDO

Making toys is a serious business at Lido (Canada) Regd., Toronto, Ontario. In their ultra-modern molding department, equipped with pneumatic Transitube systems, overhead cranes and belt conveyor systems, over 400 different designs are molded on Fellows machines.

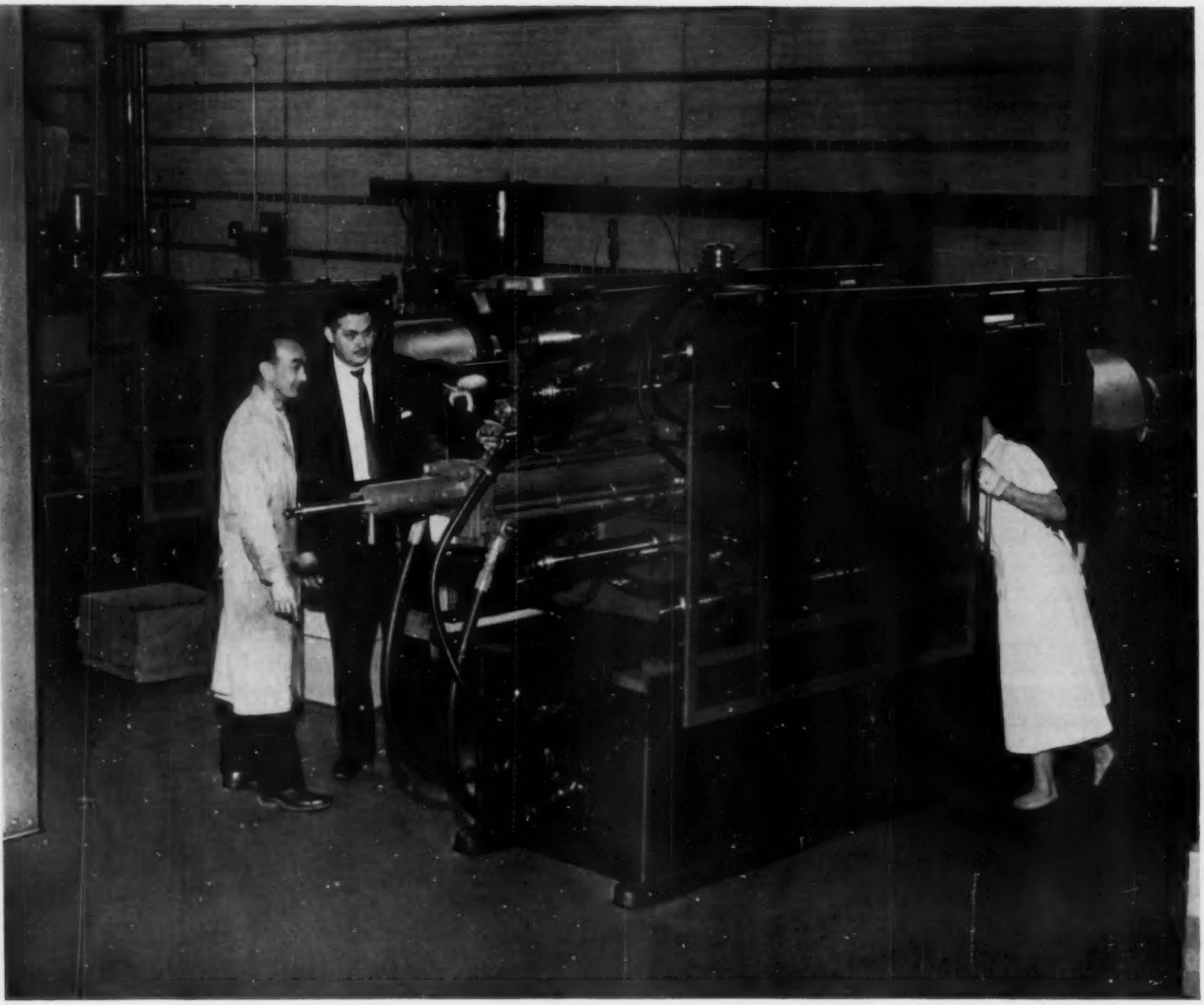
Founded only five years ago, this progressive company has grown so fast it now occupies over seven times the original floor space.

At the heart of Lido's efficient manufacturing process are Fellows No. 12-350 Injection Molding Machines. In many cases these machines of intermediate size are faster than smaller machines for large area, thin wall parts. They dry-cycle at 600 to 800 per hour and make shots up to 20 ounces with the standard Pre-Pac device which double strokes the plunger during press dwell. The Fellows No. 12-350 is easy to set up and operate. Being fully automatic, it requires only part time supervision.

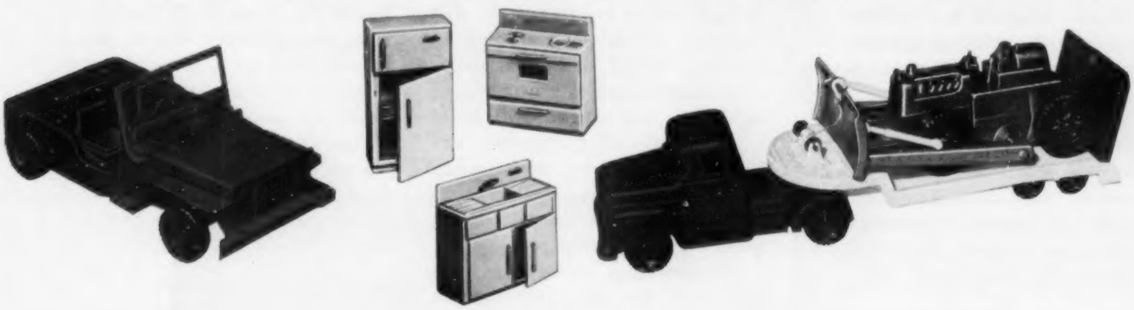
Using tough-to-mold, super-high-impact styrene as well as regular and linear polyethylene, Lido reports that their Fellows machines are both efficient and trouble-free, with no major breakdowns.

Find out for yourself how Fellows injection molding machines can help you lick even the toughest jobs. Your Fellows representative will be pleased to give you complete information.

Lido's new Factory and Offices



George Suzuki, Molding Supervisor-attendant and Mr. Moe S. Smith, President in Lido molding department



Fellows

injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY *Plastics Machine Division,* Head Office and Export Department, Springfield, Vermont
Branch Offices: 1048 North Woodward Ave., Royal Oak, Mich. • 150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39 • 6214 West Manchester Ave., Los Angeles 45

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prepared from a given formulation. Compressive and tensile strengths at room temperature are lowered somewhat depending on the amount of flame retardant used. Compressive strength at elevated temperatures is not affected, while dimensional stability under humid aging conditions is improved.

One-coat organosol coating

A series of organosol coatings, designated Sterilkote 360, that give good metal adhesion with only one application and no primer have recently been introduced by Bradley & Vrooman Co., Chicago, Ill. Laboratory tests reported by the company indicate the new materials are much more abrasion-resistant than conventional coatings requiring two applications and priming. Sterilkote one-coat organosols may be applied by manual, automatic, or electrostatic spray equipment as well as by regular and reverse roll-coaters. The new organosols can be supplied in a wide color spectrum. Metal shelving and cabinets, display racks, metal furniture, office equipment, and interior panels of cars, buses, and trains are just a few items using these coatings.

Vinyl-to-metal adhesives

A new, complete line of adhesives for vinyl-to metal-laminations has been announced by National Starch and Chemical Corp., New York, N. Y. Tradenamed Vy-Metal Adhesives, the group bonds vinyl films to steel, aluminum, and magnesium metals. Applications include card table tops, luggage, typewriter cases, television cabinets, elevator doors, automobile dash boards, etc.

Increases adhesive properties

A prime coat system specifically designed to increase the adhesive properties of hot polyethylene extrusions to cellophane and foils has been developed by the Adhesives & Chemicals Div. of The Borden Chemical Company. Called SO-242, the product is applied directly to the cellophane or foil by wash coat prior to the extrusion of polyethylene, and then air dried. Coverage is rated at less than 1/10 lb. per 3000 sq. ft. of dry ream. Weight per gallon is approximately 6.5 pounds, according to the company.

Improved printability and bondability of laminates

A new finish which improves the printability and bondability of epoxy and silicone laminated plastics is now offered by Taylor Fibre Co., Norristown, Pa. Known as B Finish, the new process produces a slightly dulled surface which holds all types of inks commonly used to print panel boards and other laminate parts and eliminates the need for sanding. Since sanding can increase the cost of laminates up to 40%, the savings made possible by the new finish are considerable. So little of the surface of the laminate is removed that the effect on thickness tolerance is claimed to be undetectable.

High bond strength adhesive

An adhesive especially designed for bonding rigid and unsupported vinyl products has been developed by the UBS Chemical Co., Cambridge, Mass. Designated H-523 Ubabond, this modified acrylonitrile rubber based cement develops a high initial bond strength that markedly increases upon aging. In addition, H-523 can be heat- or room-temperature cured, has a long color life, and can be used under a wide range of temperature and humidity conditions, the company claims. It can also be used in bonding steel, tinplate, leather, wood, glass, ceramics, and paper.

The above is another reminder that vinyl has many uses in the construction industry and a good bond to substrates is a most helpful aid to its promotion.

Paints for foam plastics

Availability of a new spray paint for application over expanded polystyrene products has been announced by Al-Chroma Paint Co., Stevens Point, Wis. The coating has the drying time of lacquer, the toughness and impact resistance of enamels, and will not dissolve the foam the company claims. It can be furnished in any color, including silver and gold, and in either a flat, semi-gloss, or gloss finish.

Metallized Mylar laminations

To meet a demand for metallized decorations Coating Products Inc., Englewood, N. J., has developed a quartet of new metallized Mylar-to-fabric combinations:

Mylar laminated to a flannel backing where extremely soft, flexible base materials are required. Suitable for women's shoes, belts, handbags, cosmetic cases, and other products, these laminations are available in standard gold, chrome, and other metallic colors.

Mylar laminated to vinyl-coated cotton sheeting woven on a bias for extra tensile strength. Expected to be adopted by the shoe trade which had been seeking a Mylar laminate that can take maximum pull.

Mylar laminated to general-purpose vinyl-coated cotton sheeting used in manufacture of wallets, dressing cases, and other highly competitive items. Claimed to be lower in cost than other laminations of its type.

Mylar laminated to cotton backing; has high tensile strength.

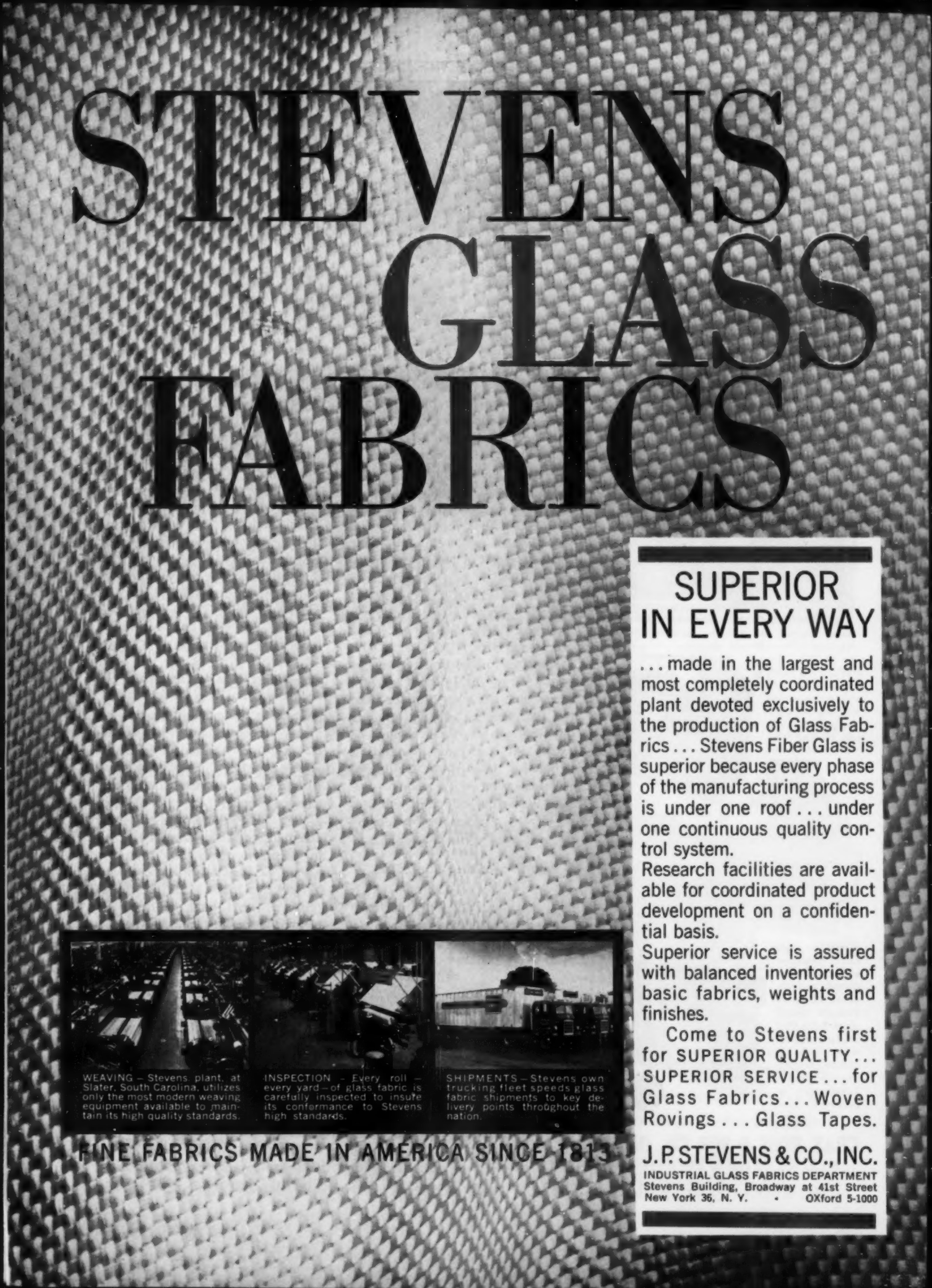
Non-toxic slip agent

A slip agent for polypropylene extrusions, said to be non-toxic and to have high-temperature stability, has been announced by Fine Organics Inc., Lodi, N. J. Designated Ram, the material is also suggested for use as an aid to mold release in injection molding, to reduce static electricity accumulation, and for high-temperature work in laminating polyethylene. Ram is effective in very low concentration, the company claims, and hardly increases the cost of the finished product.

How they did in 1960

Hercules growth in plastics. Eight percent of Hercules Powder Co.'s net sales of $336,905,000 in 1960 was for plastics. This compares with 7% of $283,650,000 in 1959. Net income for the company in 1960 was $27,165,000, compared with $23,397,000 in 1959.

Capital expenditures in 1960 amounted to $59 million, an all-time high, with a projected $50



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WEAVING – Stevens plant, at Slater, South Carolina, utilizes only the most modern weaving equipment available to maintain its high quality standards.
INSPECTION – Every roll – every yard – of glass fabric is carefully inspected to insure its conformance to Stevens high standards.
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... made in the largest and most completely coordinated plant devoted exclusively to the production of Glass Fabrics ... Stevens Fiber Glass is superior because every phase of the manufacturing process is under one roof ... under one continuous quality control system.
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million in 1961. Two of the major capital expenditures in 1960 were the polypropylene plant at Lake Charles, La., and expanded facilities for dimethyl terephthalate, which is used in the manufacture of polyester film and textiles.

Polymer Corp. Sales of over $8 million in 1960, or 12.6% above $7.1 million in 1959, were reported by Polymer Corp., Reading, Pa. manufacturer of nylon and Teflon semi-finished forms and shapes, and developer of a fluid-bed process for coating metals with plastics materials. Net profit was $478,000 in 1960, compared with $517,000 in 1959. Increased expenditures on research and expansion accounted for the difference. President Louis L. Stott stated that sales were only $711,000 with a profit of $33,600 just 10 years ago.

Foster Grant Co. Net sales for fiscal 1960 of $34,944,790, compared with $29,340,189 for 1959, are reported by Foster Grant. Net earnings were $2,103,540 for the fiscal year ended Sept. 30, compared with $1,744,191 for the similar previous period. President Joseph C. Foster asserts that the growth of the plastics chemical industry is levelling off, although markets continue to expand. It is assumed that this is a hopeful statement which means that expansion of capacity to produce is levelling off, while end uses for various plastics are broadening out to form a greater base.

Expands molding capacity

One of the largest Hydraulic Mfg. Co. injection-molding machines known has been acquired by A. L. Hyde Co., Grenloch, N. J. The new press has a capacity of 300 oz. per shot. It is 40 ft. long; horsepower is 275; clamp is 1500 tons; daylight opening is 9 feet.

This new piece of equipment has special controls for use with nylon, acetal, polycarbonate, and similar engineering-type materials. Combined with the company's other presses, says A. S. Hyde, president, the firm's flexibility includes facilities ranging from 4 to 300 ounces.

Mr. Hyde also announces production of Zytel 31 rod, which is a new product in the electrical grade of nylon. Hyde's Zytel 31 rod will be available in diameters from ¼ in. to 3 in. in natural colors only. Zytel 31 has a lower moisture absorption rate, and is more dimensionally stable than general purpose grades of nylon. It can be used to advantage throughout the electronic, radio, and electrical fields.

Offers plastics degree

Los Angeles Trade-Technical College opens registration this spring for a two-year plastics program which will lead to an AA degree in Plastics Technology. The course has been divided into two phases. During the first year, students will be given a general survey of the field including its trade terminology, origins, development, and future. Second year study will concentrate on training students in the six major production operations—reinforced, compression, thermoforming, blow, and injection molding, and extrusion. Head instructor of the program is A. V. Keller. For additional information about this program, write to the college's Guidance Center, 400 W. Washington Blvd., Los Angeles 15, Calif.

American Plastics Institute to be launched in 1961

America's burgeoning plastics industry is soon to have its own Plastics Institute. Assured of industry-wide support by the replies received from a series of questionnaires distributed during the past few months, the Plastics Institute Committee decided, at a meeting held on Jan. 23 in Washington, D. C. during the Annual Technical Conference of the Society of Plastics Engineers, to proceed with formal incorporation of the Plastics Institute of America as a non-profit organization.

The projected Institute will be concerned primarily with basic, fundamental research into the properties and characteristics of plastics materials and other significant aspects of the science and engineering of plastics, and will disseminate the findings of this research to all levels of plastics production, processing, and end-use. The Institute will also be concerned with the education, at the graduate-school level, of qualified plastics engineers and chemists. For this purpose, it will affiliate

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with one of this country's leading educational institutions, which has not as yet been selected.

Italian association formed

Assocomaplast is the name of a new association of Italian manufacturers of plastics and rubber working machines. The full name of the organization is Associazione Nazionale Costruttori Macchine Per Materie Plastiche E. Gomma and its address is Piazza Diaz 2, Milano, Italy. It comprises at present 28 members, and the president of the organization is G. Triulzi of A. Triulzi S.A.S., also of Milano.

Delrin screws

Expanding its line of threaded fasteners, Gries Reproducer Corp., New Rochelle, N. Y., will introduce a range of molded Delrin screws at Booth No. 4030 during this year's IRE Show in New York's Coliseum, March 20 to 23. The new Delrin line parallels the types and sizes of GRC molded nylon screws, and will complement the nylon through its own unique property advantages.

Flexible magnetic material

Since the announcement of the basic flexible, continuous, permanently magnetic material Magnyl in 1960, quite a number of applications have been developed. These include: A tape with a protected, pressure-sensitive backing on the non-magnetic side to make its application more versatile and easy. A lamination of thin (0.002-in. or 0.003-in.) steel to the non-magnetic side of the material, which enhances magnetic attraction by as much as 50 percent. A sandwich of Magnyl between two pieces of steel which act as pole shoes, which produces a very strong magnet with a small segment of the material, making it adaptable to closures for cabinet doors and other builders' hardware items.

Magnyl is now used in fields ranging from electronics to toys, games, and novelties. Uses are in development in the fields of advertising display, visual communication, production control, bulletin boards, fishing tackle, luggage, per-

sonal leather goods, military visual training and control, air-traffic control systems, editorial make-up boards, and many others. Magnyl is also being market-tested for distribution to consumers for do-it-yourself use through hardware stores, housewares departments, supermarkets, and other retail outlets.

Johns-Manville tapes

In announcing the product integration of two plants in New Hampshire and South Chicago, Johns-Manville has stated that it will produce two new heavy strapping tapes, one of which is transparent glass fiber or rayon transparent tape, and the other a polyethylene pipe wrapping tape to supplement vinyl chloride tape now made by the company. Other new products include a silver-colored polyethylene laminated cloth tape used as a joint sealer in duct insulations.

Polystyrene igloos for everyday use

Design, manufacture, and marketing of lightweight, free-standing weatherproof shelters of geodesic dome design to meet the needs for inexpensive but sturdy shelters and emergency housing has been announced by Monsanto Chemical Co. Trademarked Geospace, the structures will be produced by Filtered Rosin Products Co., Baxley, Ga., a wholly-owned subsidiary of Monsanto's Organic Chemicals Div., under an exclusive license with R. Buckminster Fuller.

The domes will be marketed initially as ready-to-assemble units of panel board consisting of a foamed styrene film-kraft paper laminate. Panels are bonded together at the site to form a self-supporting geodesic dome 22 ft. in diameter. The panels, tradenamed Fomecor board, are fabricated by a jointly-owned subsidiary of Monsanto and St. Regis Paper Company.

Monsanto also disclosed that it has purchased the assets of Geocentrics Inc. of St. Louis which has been engaged in design and development of commercial geodesic domes. Bennett Shapiro, formerly president of Geocentrics Inc., has joined Filtered Rosin Products Co. as director of development.

Lloyd D. Shand, formerly product sales manager for paper chemicals with Monsanto's Organic

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Chemicals Div., has been assigned on temporary duty with Filtered Rosin as director of marketing for the Geospace project. Robert H. Young, a member of the division's manufacturing department, has been transferred to Filtered Rosin to assist in production aspects of the Geospace project.

Fomecor containers. Alton Box Board Co.'s container division, Highland, Ill., has been licensed to produce and market containers fabricated from Fomecor board. It is suggested for packaging cut flowers, chemicals such as bottled nitric acid, frozen meats, delicate instruments, and many similar items.

Molded "polyakrylonitril"

Molded acrylonitrile is seldom mentioned in the United States. One authority says that acrylonitrile is not too difficult to polymerize but once that is accomplished the finished resin seems almost impossible to process. But according to the press, a Russian scientist, Nikolai Semenov, has developed a transistor from this material that he claims is as good as a transistor made of germanium, is more stable, and of course less costly than those made of comparatively rare germanium. The release stated that the resin was bombarded by radioactive matter and "became as electrically conductive as germanium and silicon."

Growth potential in plastics molding

Possibilities of growth by a plastics molding plant which started from a small beginning is exemplified by Northwest Plastics Inc., St. Paul, Minn., with the announcement that a new plant is now ready to begin operations at Grundy Center, Iowa. The expansion of this company's operations since its beginning in the 1940's puts to shame the all-too-common complaint that a small plastics operator has little chance to grow or make a reasonable profit in this so-called day of cutthroat competition and absorption of small companies by large companies.

The base of Northwest's operations is in St. Paul but other plants have been added in Gastonia, N. C., Belle Plaine, Minn., and now Grundy Center, Iowa. The company now claims to be one of the largest diversified plastics molders in the upper Midwest.

The new plant in Iowa, called Plastronics Inc., will employ over 100 people at full capacity and will operate in three shifts and, according to the Iowa Development Commission, is one of the largest plants to locate in that state for several years. Contracts with Hotpoint, Maytag, and Bourns Laboratories of Ames, Iowa, created a need for expansion before the plant was even completed. Most of the molded items produced are for the electrical, electronics, and appliance industries. R. J. Twiss, formerly of St. Paul, is manager of the new Iowa facility.

President J. R. Freyermuth said earnings for the first three quarters of 1960 were 25% over the same period in 1959, or $53,400 compared with $41,800 in 1959. The company has 82,638 shares of common stock outstanding.

Heads U. S. standards group

Alfred C. Webber of Du Pont's Polychemicals Dept. has been named chairman of the United States Committee TC-61 on plastics of the International Organization for Standardization (ISO). This committee is also a subcommittee of the American Society for Testing Materials (A.S.T.M.) Committee D-20 and provides technical guidance to the secretariat of TC-61, which is maintained by the American Standards Association.

A. C. Webber

ISO/TC-61 has been active for the past 10 years; and its accomplishments at the October 1960 meeting held in Prague, Czechoslovakia, were detailed in December MPI, p. 156. Mr. Webber will head the American delegation at the 1961 ISO plastics committee meeting to be held in September, in Turin, Italy.

The work of the International Organization represents a solid succession of achievements, including a multi-language glossary and over 30 test methods. For projects cur-

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rently being handled by the various working groups, refer to the Modern Plastics article.

New companies

Summit Plastics Industries Inc., 40 Brown Ave., Springfield, N. J., has been organized by **Benjamin Messing,** former president and founder of Jason Corp., and **Irving Starobin,** formerly in charge of the finishing division of Harte & Co. The new firm will specialize in expanded vinyl foam and polyurethane foam laminations to all types of webs.

Plastics Pacific Chemical Co., 10819 Venice Blvd., Los Angeles, Calif., established by **Francis S. Stewart,** industrial chemical engineer, will be devoted to plastics research and development.

Brand Plastics Co. has been organized for the production of styrene polymers, and is constructing a plant at Willow Springs, Ill., with initial shipments scheduled for the second quarter of 1961. **Dr. J. L. McCurdy** is president, and **R. L. Curtis** is secretary-treasurer. Both men were formerly with Rexall Drug & Chemical Co.

Thomas Plastikraft Inc., New Hartford, N. Y., has been formed by **Richard H. Thomas,** formerly of General Electric Co. The firm will specialize in plastics packaging, with emphasis on thermoformed foam and molded foam application.

Expansion

Petro-Tex Chemical Corp., Houston, Texas, has announced plans to construct a multimillion lb. tetrahydrophthalic anhydride plant. The material can be substituted for phthalic anhydride in alkyd and polyester resins to give better initial color, better color retention, and better adhesion, the company claims. Applications also include plasticizers. Petro-Tex will have a basic raw material supply position on both of the starting materials for tetrahydrophthalic anhydride, butadiene, and maleic anhydride.

Packaging Corp. of America, Evanston, Ill., has announced a second major move into the expanded polystyrene plastics field with the acquisition of the plastics division of **Lakeside Mfg. Co.,** Milwaukee, Wis. Terms were not disclosed. Recently Packaging Corp. acquired **Worcester Moulded Plastic Co.,** Worcester, Mass. Both acquisitions will form the nucleus of a new plastics division to be formed by Packaging Corp.

Son-Mark Industries, Philadelphia, Pa., has purchased **Spaulding Industries Inc.,** Chicago, Ill. manufacturer of plastic dinnerware and associated items. According to **Milton Briskman,** who was named manager of Spaulding, the company will produce a new line of dinnerware tradenamed Melco-Ware, which was exhibited at the Housewares Show in Chicago in February. Spaulding uses melamine for the plates and the rest of the dinner

service is molded of Dylene polystyrene, a product of the Plastics Div., **Koppers Co. Inc.**

Ferro Corp., Cleveland, Ohio, has expanded its plastic colorant operations into the New York-New Jersey area with the establishment of a $50,000 plant and warehouse in Elizabeth, N. J. The new facility will consist of offices, storage space, and equipment for custom blending and packaging of powdered dry colorants. The plant will also stock paste colors and gel coats.

Wyandotte Chemicals Corp., Wyandotte, Mich., has put its first Eastern plant on stream at Washington, N. J. The new facility makes polyethers for flexible and rigid polyurethane foams, elastomers, and coatings. **Lloyd Fisher** is manager and **Burnett Eddy Jr.,** assistant manager of the new plant. **I. A. Davis** is project manager in charge of the start-up.

Dynacron Electronics Corp., wholly-owned subsidiary of **Trans-United Industries Inc.,** has acquired **Electronic Plastics Co.,** Richmond Hill, N. Y. The new acquisition will operate as a division and manufacture electronic potting compounds, plastic foams, laminating and impregnating resins, casting resins, coatings, and reinforced plastic laminates.

Vogt Mfg. Corp., Rochester, N. Y., has acquired 100% control of **Protection Equipment Co.,** Sunbury, Pa., which will operate as the Sporting Goods Div. of Vogt. Products include athletic equipment such as football pads, gymnasium mats and wrestling mats; and marine equipment such as life vests, work vests, ski belts, swim jackets, boat bumpers, life rings, and flutterboards. Products are made with an all plastic construction which consists of a closed cell vinyl foam material with a plastic coating. In the case of athletic equipment, a foam material with outstanding shock absorbing properties is used.

Protection Equipment Co. was started some 10 years ago by **"Doc" Kavanagh,** Cornell University trainer, **George K. "Lefty" James,** until recently head football coach at Cornell, and **Lewis B. Swift Jr.,** athletic specialist at **Eastman Kodak Co.** The new company designed football pads and wrestling mats to take advantage of these new materials. The outstanding shock absorbing properties of these foam materials offer protection to opponents as well as better protection to the wearers. The all plastic construction also provides light weight pads that do not absorb perspiration and can be washed clean. It was also found that this construction had a potential in the marine field as the products do not absorb water and will not rot.

Enjay Chemical Co., a division of **Humble Oil & Refining Co.,** announced plans for expanded facilities at its Baytown, Texas refinery that will increase production capacity of benzene from 30 million to 55 million gal./yr. and toluene from 32 million to 55 million gal./year. Enjay reported that Humble's total benzene capacity will be increased to about 80 million gal./yr. when the new facilities

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go into operation at Baytown early in 1962. This figure includes production at the Baton Rouge, La. refinery. Humble will also construct toluene dealkylation facilities for the production of benzene, using a process developed in the Humble laboratories, the company said.

Combined Electronics Inc. has leased a new factory and office building at 4616 W. 20 St., Cicero, Ill., and will expand its production of molded plastic wiring panels. The new plant will be capable of manufacture of 200,000 sq. in. of molded circuitry per shift or 48,000 average size panels per day, according to Samuel H. Levinson, president.

Buhler Mill Engineering Co., Minneapolis, Minn., and **Buhler Bros. Inc.,** Englewood, N. J., have merged and will be known as **Buhler Corp.** The new firm is constructing an 18,000-sq.-ft. building at 8925 Wayzata Blvd., Minneapolis, and will introduce several lines of injection molding equipment. Both companies are subsidiaries of **Buhler Bros.,** Uzil, Switzerland.

Staatsmijnen, Limburg, Holland, producer of caprolactam and urea, is constructing a methanol-based formaldehyde plant adjacent to its present location. The new plant will have an annual capacity of 25,000 tons (40% formaldehyde in an aqueous solution).

Kraloy Plastic Pipe Co. and **Chemtrol,** manufacturer of plastic valves and pumps, have been combined into one organization, **Kraloy-Chemtrol Co.** The new company will remain a subsidiary of **Rexall Drug & Chemical Co.** Officers include **Victor J. Haydel,** president; **Russell W. Johnson,** vice-president and general sales manager; and **Donald Jenson,** manager of engineering and production.

Abington Textile Machinery Works, North Abington, Mass., has acquired **Expandex Corp.,** Wauregan, Conn. By utilizing Abington's manufacturing facilities, **(To page 235)**

Expandex, custom molder of expandable polystyrene, will now also offer a line of standard molding equipment as well as custom designed systems.

Harvill Corp., Los Angeles, Calif. die casting manufacturer, has purchased **American Aerophysics Corp.,** Los Angeles manufacturer of molded and laminated products used in nose cones, radomes, rocket motor cases, etc. The new acquisition will be operated as a wholly-owned subsidiary.

Illinois Tool Works has completed construction of a 76,000-sq.-ft. plant for its **Conex Div.** at Des Plaines, Ill. Conex manufactures plastic containers and packaging products for the vending, dairy, and food industries.

Diamond Plastics Industries Inc., Roanoke, Va. manufacturer of injection molded containers, has merged with **Paper Package Co.,** Indianapolis, Ind. producer of plastics and paper packages, to form a new company called **Creative Packaging Inc.** The new company will be responsible for sales management and marketing of all products manufactured by the two merged companies, which will function as divisions of the new corporation.

Loral Electronics Corp. and **Radiation Applications Inc.,** both of New York, have established a joint venture company, **Radiation Materials Inc.,** to investigate development of and markets for irradiated insulation products such as polyolefin wire and cable insulation.

Monsanto Chemicals Ltd. is expanding its high-pressure polyethylene production facilities at its plant in Fawley, Southampton, England. The first stage will be operational in 1963 and will add approximately 50% to present capacity which is in excess of 17,000 tons a year. This is the second expansion of the Fawley installation which started in 1959 with an original capacity of 10,000 tons a year.

G-L Electronics Co. Inc., Camden, N. J. manufacturer of magnetic components for the electronics industry, has acquired **Modular Molding Corp.,** West Trenton, N. J.

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manufacturer of fibrous glass reinforced products. **Albert R. Pollack** will continue as president of Modular Molding Corp., which will be operated as a wholly-owned subsidiary of G-L Electronics.

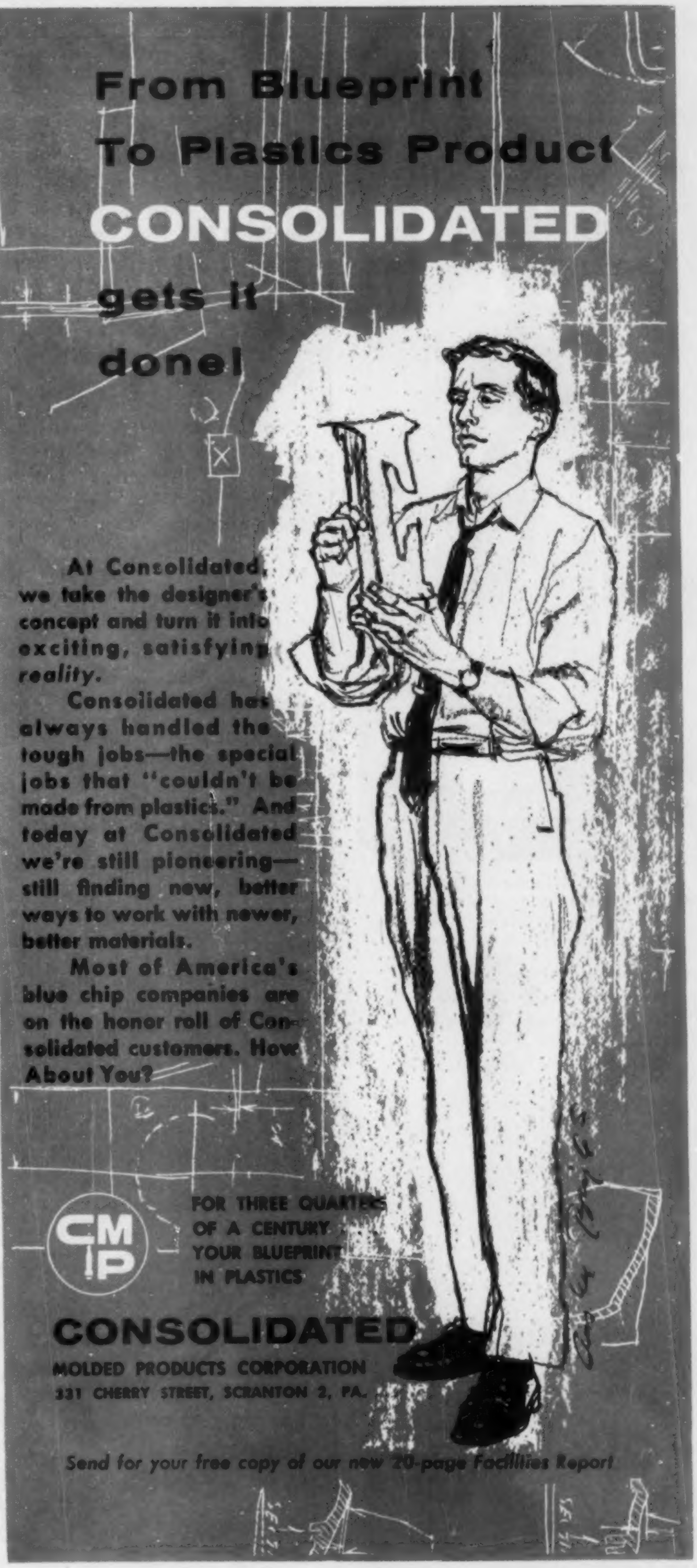
Cyanamid International, a division of **American Cyanamid Co.,** has formed a new company to manufacture and market Formica laminated plastics in Brazil. The new company, **Formica Plasticos S.A.,** Sao Paulo, was formed by Cyanamid's purchase of the plant and assets of **Plasticos do Brasil S.A.,** hitherto a licensee of **Formica Corp.,** a Cyanamid subsidiary. **Kenneth P. Pitt,** formerly U. S. Eastern regional sales manager for Formica Corp., is managing director of Formica Plasticos.

H. P. Smith Paper Co., Chicago, Ill., has increased coating facilities to six production machines in addition to its laboratory coating equipment with the addition of a new 76-in. polyethylene extrusion coater made by Frank W. Egan & Co. H. P. Smith produces polyethylene-coated papers, films, foils, boards, and fabrics.

All six coaters are currently operating on a round-the-clock basis, and peak production can be maintained coordinated with six 85,000-lb. storage silos mounted on the plant's roof. H.P.S. polyethylene-coated products include stretchable polycoated kraft wraps for food and industrial applications, and polyfoil-film coatings and laminations.

Lunn Laminates Inc., reinforced plastics molder, has acquired the assets of **Mariner Laminates Inc.,** Copiaque, N. Y. designer and molder of fibrous glass laminated lifeboats, life rafts, buoyancy apparatus, and other marine life saving equipment. **James B. Sullivan,** former president of the lifeboat company, is now sales manager of Lunn's Marine Div.

Mobil Chimica Italiana S.p.A., a newly formed Italian chemical company affiliated with **Socony Mobil Oil Co. Inc.,** will build a plant



THE PLASTISCOPE

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at Naples to produce benzene, ethylbenzene, orthoxylene, and paraxylene. Estimated initial output, according to **Paul V. Keyser Jr.**, president of **Mobil Chemical Co.**, would amount to 39 million gal. of which more than 75% will be benzene and orthoxylene. Raw materials will come in large part from the adjacent refinery operated by **Mobil Oil Italiana.**

Sterling Extruders, Linden, N. J., has completed the second phase of its $250,000 expansion program with the establishment of new machine shop facilities in a recently completed building adjacent to the existing Sterling plant. This new building and plant brings Sterling Extruders' total manufacturing area to 29,000 sq. feet.

Deceased

Charles R. Van de Carr Jr., 74, retired president and director of **The Mead Corp.,** died Dec. 28 in St. Petersburg, Fla.

Karl Lissmann, 85, founder of **Alkor G.m.b.H.,** Munich, Germany manufacturer of vinyl plastics, died quietly in his sleep Dec. 25, in Munich.

Louis J. Woolf, 70, chairman of the board of **H. Kohnstamm & Co. Inc.,** died Jan. 12 in New York City. He was with Kohnstamm 47 years.

Louis R. Kessler, 51, operations vice-president of **Owens-Corning Fiberglas Corp.,** with headquarters in Toledo, Ohio, died Jan. 20 after a heart attack suffered during a business trip in Warwick, Ga.

Ferdinand B. Savarese, 44, director of Laboratories for **Advance Solvents & Chemical,** New Brunswick, N. J., died Jan. 3 of a coronary thrombosis.

Coming events

Plastics groups

April 4, 5: Society of Plastics Engineers Inc. (S.P.E.), Pioneer Valley Section, Retec, "Plastics Injection Molding Workshop," Holy Cross College, Worcester, Mass.

April 12-14: Deutsche Kunststoff-Tagung, Berlin, Germany.

April 17-May 7: Plastics Hall '61, Tokyo International Trade Fair. Contact: Japan Society of Plastics Technology, No. 8 2-Chome Ginza-Higashi, Tokyo, Japan.

April 20: S.P.E. Western New England Section, Retec, "Plastics—A New Dimension in Building," Springfield Museum of Art, Springfield, Mass.

April 26-28: The Society of the Plastics Industry (S.P.I.), 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Calif.

May 8, 9: S.P.I. 19th Annual Canadian Section Conference, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada.

June 5-9: S.P.I. 9th National Plastics Exposition and National Plastics Conference, Coliseum and Commodore Hotel, New York.

June 16-25: Europlastica 1961, Palais des Floralies—Parc, Ghent, Belgium. Contact: H. P. Persin, Sec. General at above address.

June 21-July 1: Interplas 61, 6th International Plastics Exhibition and Convention, Olympia, London, England. Contact: John L. Wood, Dorset House, Stamford St., London SE 1, England.

Oct. 17-19: The Plastics Show of Canada, Canadian National Exposition, Toronto. Contact: W. B. Pryde, Show Manager, 481 University Ave., Toronto, Canada.

Other groups

April 10-13: AMA National Packaging Show, Exposition Center, Chicago, Ill.

May 16-18: Building Research Institute Spring Conferences, Shoreham Hotel, Washington, D. C.

May 17, 18: Chemical Market Research Assn., 21st Annual Meeting, Plaza Hotel, New York, N. Y.

June 9-17: ACHEMA 13th International Chemical Engineering Exposition and Congress, Frankfurt am Main, Germany.

Sept. 5-8: 11th National Chemical Exposition, sponsored by Chicago Section, American Chemical Society, International Amphitheatre, Chicago, Ill.—**End**

COMPANIES... PEOPLE

Appointments, promotions, and relocations in the plastics industry.

Breskin Publications, publisher of MODERN PLASTICS and MODERN PACKAGING, will move on March 17 to new and expanded quarters in the new air-conditioned office building at 770 Lexington Ave. and 60th St., New York 21, N. Y., five blocks from the present location at 575 Madison Ave. The new offices, which will occupy two floors, are convenient of access and will offer greater facilities for readers, including a large technical library on plastics and packaging. Complete details of the new facilities will be given in a later issue.

Allied Chemical Corp.—Plastics Div.: Henry W. DeVore appointed asst. to v-p—sales, **Bennett D. Buckles, Larry H. Austin, Bruce W. Carney,** and **James Ferguson** appointed dist. sales mgrs. for Los Angeles, Calif.; New York, N. Y.; and Chicago, Ill. districts, respectively. **C. Donald Delaney, Whiting N. Shepard,** and **David W. Towler** move up to become mgrs. of industrial and coating resins sales, and thermoplastic resins sales, respectively.


H. W. DeVore

Mr. DeVore, a pioneer in plastics, has been with the company since 1932, when he joined Plaskon Corp., and moved to New York headquarters when it became associated with Allied. Prior to his current promotion, he held a number of managerial posts in the Plastics Div.

National Aniline Div.: E. John Bartolini appointed asst. mgr., special projects. He will relocate to Australia as mgr. of operations for Allied Chemical's new nylon facilities in Homebush, New South Wales. Allied Chemical and **Polymer Corp. (Pty) Ltd.** of Australia recently announced plans to form a joint company, known as **Allied Polymer Pty. Ltd.,** to produce nylon tire cord, molding polymers, and monofilament.

Solvay Process Div.: Dr. Robert H. Reed named v-p, development, with headquarters in Syracuse, N. Y.

The Borden Chemical Co.: Raymond J. Lodge, formerly gen. mgr., resins and chemicals dept., promoted to v-p, Adhesives & Chemicals Div. **Ray T. Hanson,** formerly gen. mgr., Western operations, promoted to v-p, Western Operations Div. **Harry C. Wechsler,** formerly v-p, commercial development, promoted to v-p of the newly formed Thermoplastics Div., a consolidation of the PVC, Resinite, and Polyco-Monomer Depts.

Robert N. Stickney appointed works mgr. of the Illiopolis, Ill. plant, producer of industrial polymers; and **Herman A. Peed** named production supt., of the Leominster, Mass. plant, producer of polyvinyl chloride.

Shell Chemical Co.: D. B. Luckenbill, operations mgr. plastics and resins div., named mgr. of the polypropylene plant to be built near Woodbury, N. J. **F. G. Watson,** plant mgr. Shell Point plant, Pittsburg, Calif., named mgr. mfg., plastics and resins div. **C. H. Plomteaux** supt. Houston, Texas plant, succeeds Mr. Watson.

Shell Development Co., Emeryville, Calif.: **Theodore F. Bradley,** head of plastics and resins dept., research center, retired after 15 years with the company.

Reichhold Chemicals Inc.—Plastics Div.: Charles S. Stryker appointed sales mgr. responsible for national sales and pricing policies on polyesters, epoxies, polyurethanes, urea, and melamine resins. **William F. Turner** named dir., tech. services.

Archer-Daniels-Midland Co. has established a five product dept.—each with its own production and sales personnel—in a major reorganization of its marketing program. **Dr. George K. Nelson,** formerly mgr., industrial chemicals div., named marketing mgr. for the entire group and **J. C. Burkholder,** formerly resin div. mgr., appointed group production mgr. Product depts. and mgrs. are: resins, **W. C. Mueller;** plastics, **H. B. Finch;** industrial chemicals, **J. H. Kane;** plasticizers, **W. A. Jarvey;** nitrogen chemicals, **R. G. Freese.**

Acheson Dispersed Pigments Co., Philadelphia, Pa. mfr. of thermoplastic dispersions: **Morgan Jones** named gen. works mgr. Formerly works mgr. at Orange, Texas, he is succeeded there by **B. J. Arney. Dr. Edwin B. Carton** joined the company as mgr., R & D.

Monsanto Chemical Co.—Plastics Div.: Dr. Robert F. Wall and **Dr. T. D. McMinn Jr.** appointed scientists in the research dept. at Texas City, Texas. **Dr. Paul Ehrlich** appointed scientist in the research dept. at Springfield, Mass.

Chocolate Bayou Project, Alvin, Texas: **H. K. Eckert** appointed gen. mgr.; **Robert E. Lenz,** dir., engineering; **Robert H. Kittner** dir., market research; **Joseph Cresce,** dir mfg.; **Carl E. Pfeifer,** dir., project services.

Vinyl Fabrics Institute, New York, N. Y.: **Jules D. Lippmann,** gen. mgr., **Textileather Div., General Tire & Rubber Co.,** re-elected for a third term as pres. **Paul Howard,** pres., **Weymouth Art Leather Co.,** elected 1st v-p; and **V. W. McDaniel,** pres., **Coated Fabrics Div., Interchemical Corp.,** 2nd v-p. The Vinyl Fabrics Institute is composed of 15 companies.

Vlchek Tool Co.—Plastics Div.: Donald T. Wynne Jr. appointed v-p and mgr.; **George W. Burhoe,** sales mgr.

Union Carbide Corp.—U. C. Plastics Co.: Philip A. Thomas promoted to asst. dir., development, R & D Center, Bound Brook, N. J. He has served as a group leader of laminating, plastic foam, and compression molding development groups.

U. C. Chemicals Co.: Dr. T. J. Mahoney promoted to product mgr., rigid foam, responsible for market development of Niax polyethers.

Switzer Bros. Inc., Cleveland, Ohio supplier of Day-Glo fluorescent paints, pigments and printing inks for plastics and coatings, has opened a new plant at 9314 E. Fern St., S. El Monte, Calif. **Fred Switzer** is v-p in charge of Western operations.

Loma Industries Inc., Fort Worth, Texas, has created a Custom Molding Div., to work with mfrs. in designing, fabricating, and testing new products and components of plastics. The div., headed by **Robert Lambert Jr.,** will employ injection, blow, and foam molding, as well as the Engel process and vacuum forming techniques.

The Richardson Co., Melrose Park, Ill. mfr. of industrial plastics: **Hunter McClure** joined the commercial development dept., R&D Div.

Plastics Corp. of America, Stamford, Conn. mfr. of polystyrene resins, subsidiary of Richardson: **Marvin Becker,** formerly operating supt., Plastics Div., Monsanto Chemical Co., appointed v-p in charge of mfg.

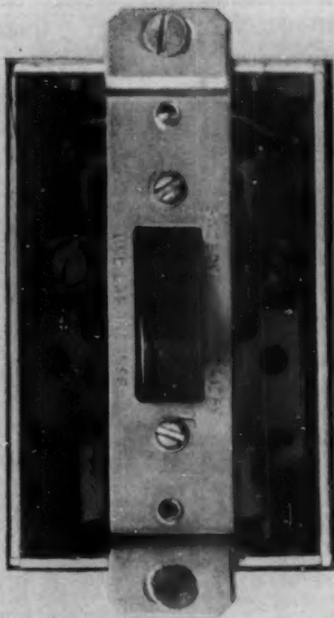
James M. Jordan promoted to mgr., plastics market research, in the Commercial Development Dept. of **Spencer Chemical Co.'s** Plastics Div.

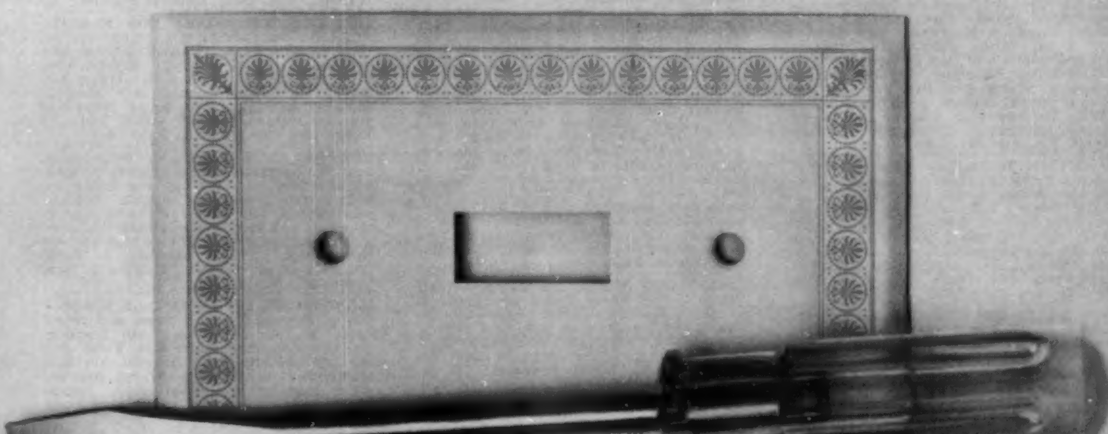
John J. Ziccarelli, formerly of National Cleveland Tool Corp., Bridgeport, Conn., is now gen. sales mgr. for **Flexabar Corp.,** Rockleigh, N. J. Flexabar makes inks, paints, and coatings for plastics and a polyolefin coating for untreated surfaces.

Corrections

"Traffic markers that shine—and last" (MPl, Feb. 1961, p. 100): Number of buttons used per mile is 880.

"The reinforced plastics travel trailer" (MPl, Feb. 1961, p. 174): Reinforced honeycomb core for the trailer was supplied by Verticel Pacific, Santa Fe Springs, Calif.—**End**





CLASSIFIED ADVERTISEMENTS

EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT

Machinery and Equipment For Sale

FOR SALE—(1) Model "R" Stokes Preform Press $1,200.00. 2 Leominster Tool Model 5C8 Injection Machines $2,250.00 each. Call or write for appointment to see in operation before removal. R. E. C. Mfg. Corp., 1250 Highland St., Holliston, Mass. GArden 9-2061.

FOR SALE—Automatic sealing machine for making transparent acetate card holders in various sizes, with a colored strip along each long side. Production rate 20 feet per minute, all material used is from roll stock. Machine in first-class condition. Kirk Plastic Co., 170 E. Jefferson Blvd., Los Angeles 11, Calif.

FOR SALE—(1) Banbury Midget Mixer 2 HP; (1) No. 3 Banbury Mixer 75 HP; (2) Baker Perkins 50 and 100 gal. Sigma Blade Jacketed Mixers; (1) No. 1 Ball & Jewell Rotary Cutter; (1) No. 18 Cumberland Rotary Cutter; (3) Mikro Pulverizers, Bantam, 1SH and 1SI; (6) Stokes Preform Presses, models R, T, DD2, DDS2, DS3 and D4; partial listing, send for details. Brill Equipment Co., 35-55 Jabez St., Newark 5, N.J. Tel: Market 3-7420.

FOR SALE metal detector RCA utility model R-200 control unit, two inch inspection aperture, inter-connection cable. High sensitivity, detects any kind of metal or alloy and easy to install. Reply Box 6849, Modern Plastics.

WHEELABRATOR PLASTIC DEFLASHERS for sale: 20-27 Tumblast, 27x36 Tumblast and No. 1 Multi-table complete with dust collectors, control panels, p.b. stations. Guaranteed to be in like-new condition. Ideal for deflashing of all plastic parts. Universal Machinery & Equipment Co., 1630 N. 9th St., Reading, Pa., FRanklin 3-5103.

FOR SALE—Erie 300 ton, 40"x30" self-contained. HPM 200 ton downstroke. Baldwin 150 ton, 30"x20" self-contained. Watson Stillman 240 ton, ten 24"x56" platens. W & W 200 ton, 24"x42". Stokes Standard 50, 100 and 150 ton Semi-Automatics. D & B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton Upstroke, 29"x21" 50 ton Birdsboro 24"x20". Stokes 15 ton automatics. Hydraulic pumps and accumulators. MPM 3½" wire covering Extruder. New ¾" plastic extruder. Other sizes to 6". Seco 6"x12" 2-Roll Mills and Calenders. Other sizes to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day Jacketed Mixers. Taylor-Stiles Pelletizer, 7½ HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for Bulletin #192. We buy your surplus machinery. Stein Equipment Company, 107-8th Street, Brooklyn 15, New York.

INJECTION MOLDING—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Elmes 60 ton high speed; Mill-Farrell 16x36; Baker Perkins SS, 2 arm, jacketed, vacuum, hydraulic tilt, 100 gal-50HP, also 150 gal-75 HP; Mixer 2 arm 150 gal. Day Imperial steel; Extruder 8" elec. heated; Ram extruder; Machinecraft Corp., 800 Wilson Ave., Newark 5, New Jersey. MI 2-7634.

FOR SALE—3300-TON TWENTY-DAY-LIGHT Board Press, steam heated platens 12'6" x 4'6", with mechanical loaders and unloaders; self-contained pumping unit; excellent equipment fully reconditioned. Reed Brothers (Engineering) Limited, Repland Works, Woolwich Industrial Estate, London S.E. 18., Cables REPLANT London.

WATSON-STILLMAN 8 ounce injection molding machine, 20 h.p. motor, Oil Gear Co. pumps, multiflex timers and clocks by Eagle Signal Timer—60 lbs. per hour—heating element 6800 watts. Used in government laboratory—Good condition $5,000 f.o.b.—D. H. Atkins, 43 Langley Ave., Newport News, Virginia. LY-61820 after 6 PM.

MOST MODERN PACKAGING AND PROCESSING MACHINERY Available at great savings. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and enamel. H. K. Porter 650 gal. Steam Jacketed Double Spiral mixers. B. P. 100 gal. Jacketed Stationary Vacuum Double Arm Mixer. Day Imperial 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Mikro Pulverizers, Models Bantam, 1SH, 2TH, 3TH and 4TH. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters. Colton 2RP, 3RP, 3B, 5½ T Tablet Machines. Stainless Steel Jacketed Mixing Kettles 100 and 150 gal. capacities. Day Ro-Ball Sifters. Package machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning machines—Ceco, Pneumatic Scale, Jones. Filling machines—all types and sizes. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N.Y. Phone: CAnal 6-5333.

FOR SALE—Negri Bossi blow molder #220 Kinematic with 60 mm. extruder two station blowing head. Capacity 1 liter. Used only a few hours experimentally. Price $6000. Forbes Products Corp., Rochester 20, N.Y. Greenfield 3-0482.

FOR FAST DELIVERY of good equipment call on your first source FMC! Extruders: NRM 1½"; Royle 2"; Hydr. Strainer 15". Rotary Cutters by Sprout Waldron, (15 HP), Ball & Jewell No. 1 and 2; IMS Model MF. Preform presses: Stokes No. 280, Colton #5½. 3 Roll Calendar, 22"x58" with accessories. FB Unused 2 Roll Mills, 14"x30" Uni-Drives. Baker-Perkins Dbl. Arm Jktd Mixers to 300 Gal. FALCON Dbl. Ribbon Blenders, all sizes. 6 Stokes Self Contained Molding Presses. 150 Ton with 3 HP Hydr. Pump System. 2 HPM Self Cont. 25 Ton, 18" Stroke, 40" Dlt. 1 HPM Self Cont. 7 Ton Press; 12" Stroke S.B. 450 Ton Press with 36"x36" Platens. Inquire about the FMC Rental-Purchase Plan. First Machinery Corp., St. 8-4672. 209-289 Tenth St., Bkln. 15, N.Y. Cable: "Effemcy."

FOR SALE—#3-A Banbury mixer, 200/100 HP 2 speed motor; 2" Hartig electrically heated plastics extruder; 100 ton self-contained Baldwin transfer molding press; 3 Ball & Jewell granulators 15, 10, 7½ HP; 300 ton Dunning & Boschert compression molding presses. Chemical & Process Machinery Corp., 52 9th St., Brooklyn 15, N.Y., HY. 9-7200.

EXCESS INVENTORY SALE EQUIPMENT—One (1) NBV 60 Negri Bossi Italian Extruder, 18:1 ratio with 8 hp motor and variable speed pulley drive, 220 volt, 3 phase, 60 cycle, 4 instrument control panel, complete. Price: f.o.b. New York—$4,500.00 Two (2) SCAE Shifting Table, Italian Blow Molding Machines, Double Platen, fully automatic, pneumatically operated, 220 volt, 3 phase, 60 cycle, with controls and extrusion cross head (2½"). Price: f.o.b. New York $5,250.00 each including Burch & Bailey license $6,750.00 each One (1) Manifold Type Blow Molding Machine, complete with manifold, air operated, 8" clamp cyl., 12"x20" Platens, with controls. USA made. Price: f.o.b. New York—$8,600.00 One (1) 2½" Olympia Extruder, 20:1, with controls and 15 hp U.S. Vari-drive. Price: f.o.b. New York—$8,700.00. The Rainville Co., Inc., 839 Stewart Ave., Garden City, N.Y.

FOR SALE—Stokes Model R Single Punch Tablet Press. Direct connected to 5 HP U.S. Vari Drive. Bipel 35 ton Tablet Preform Presses with Vari Drives. 2 available. INJECTION MOLDING MACHINES—1 oz. Van Dorn, 1 oz. DeMattia, 8 oz. Reed Prentice, 12 oz. DeMattia, 16 oz. HPM, 24 oz. Watson Stillman and other sizes in stock. Ball & Jewell #1½ Rotary Scrap Grinder, Ball & Jewell #½ Scrap Grinder. Cumberland and Foremost Grinders, from ½ HP to 5 HP. Transfer Molding Presses—300 ton Stokes. Smaller sizes available. Over 400 compression molding presses in stock. Sizes up to 2000 ton. Many multi-opening. Liquidations our specialty. What do you have for sale. We will finance your purchases. Johnson Machinery Company, 90 Elizabeth Ave., Elizabeth, New Jersey, ELizabeth 5-2300.

FOR SALE—(3) Automatic Stokes, 200 D3-25 Ton, (1) 600 B Strauss 50 ton, (2) 500 ton R-D Wood Embossing Presses 21" Dia. Ram, 3M Working Pressure Electric Platens, 55"x32"—500 ton, 2-ram, 60"x60" Platen Area, 3—24x24x14" Ram, 24"x54"x14" Dia. Rams, 350 ton 8—3½" openings 6 oz. Watson-Stillman Injection, Baker Perkins size, 15, 4 day churns. Brewster Rubber Machinery Co., 349 E. Exchange Street, Akron 4, Ohio, FRanklin 6-2911.

FOR SALE—Sturtevant #50B stainless rotary blender; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 Stainless jacketed resin kettle; American 42"x120" dbl. drum dryer, ASME code, stainless trim; 2750 gal. T316 Stainless pressure tanks, coils, dished heads; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Mikro #3TH pulverizers; Worthington 70 cu. ft. rotary blender; we pay cash—top dollar—for idle, surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

FOR SALE—1—16 oz. HPM Injection Molding Machine 350-H-16, Serial #45-545. $7,500.00 1—16 oz. HPM Injection Molding Machine 350-H-16, Serial #55-101, $9,500.00 1—75 ton Hi Mac downward acting Hydraulic Press 9 inch stroke, $250.00 1—100 ton HiMac downward acting Hydraulic Press 4 inch stroke, $250.00. National Products Company, 6100 Wilson Ave., Kansas City, Mo.

COMPLETE EQUIPMENT for production of Poly Vinyl Chloride foam including 10 H.P. mixer, Girdler 4" Votator, 6 ton York Ammonia compressor, 120 KW oven 44x7 feet, pumps, conveyors, 10 ton Worthington air conditioner, assorted furniture cushion molds. Reply Box 6856, Modern Plastics.

AVAILABLE in the Miami area, 8-oz. Reed-Prentice 10-D-8 Injection Molding Machine. Price $5,000.00. Security Plastics, Inc., 4295 E. 11 Ave., Hialeah, Fla.

Machinery Wanted

WANTED to buy a three roll calender—length about 90". Reply Box 6849, Modern Plastics.

Materials Wanted

WANTED—Urea and melamine molding powders—distress and surplus supplies wanted. Box 6847, Modern Plastics.

GET THE TOP MONEY FOR PLASTIC SCRAP—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, acetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. WRITE, WIRE, TODAY! Reply Box 6834, Modern Plastics.

PLASTIC SCRAP WANTED—Acetate, acrylic, butyrate, polyethylene, styrene, vinyl, nylon, etc. We pay top dollar for your plastic scrap and surplus molding powders in any form. We also supply molding powders to the plastic industry at reasonable prices. Please contact for information: Philip Shuman & Sons, Inc., 571 Howard Street, Buffalo 6, New York—tel: TL 3 3111.

WANTED—PLASTICS OF ALL KINDS—virgin, reground lumps, sheet and reject parts. Highest prices paid for Styrene, Polyethylene, Acetate, Nylon, Vinyl, etc. We can also supply virgin and reground materials at tremendous savings. Address your inquiries to: Goldmark Plastic Compounds, Inc., 4-05 26 Ave., Long Island City 2, N. Y. RA 1-0880.

Materials For Sale

FOR SALE—Linear Polyethylene powder natural. Huge quantity exceedingly low price depending on volume. Write Box 6835, Modern Plastics.

(*Continued on page 244*)

(Continued from page 242)

REDUCED PRICES on surplus spot lot virgin colors. Straight lot colors run from 200# to 20,000# in Hi-Imp.; Med-Imp.; Gen. Purp. Styrenes and Polyethylenes. Write for samples. Write Box 6838, Modern Plastics.

WE HAVE APPROX. 50 Tons of 10" Phono. Records. All one formula that contains 30% vinyl. Can be enriched by adding vinyl to make 45 R.P.M. records. Ideal for Thermo Plastic molding of radio bases, flower pots, ash trays, decorator products, etc. will sacrifice. Regent Records, Inc., 56 Ferry St., Newark, N.J.

FOR SALE—5,000 lbs. white rigid vinyl sheet scrap; 15,000 lbs. jet black C/A pellets; 20,000 lbs. virg. & repr. natural P/E pellets; 14,000 lbs. Natural Polypropylene. Reply Box 6844, Modern Plastics

LOW PRICES ON SURPLUS BLACKS—
38,000# Hi-Imp. Styrene Utility Black.
34,000# Med-Imp Styrene Utility Black.
42,000# Gen-Pur Styrene Utility Black.
32,000# Gen-Pur Styrene Hi-Lust Black.
39,000# Butyrate "Medium Flow", Black.
41,000# Acetate, "Medium Flow", Black.
49,000# Polyeth. low den., MI 2, Black.
Erisco Formed Wire Company, Inc., P.O. Box 75, Erie, Penna.

Help Wanted

SALESMEN — EXPERIENCED — To sell heavy plastic sheet, polystyrene and other types, to vacuum forming and related industries. Top flight company headquartered in New Jersey. Replies confidential. Box 6851, Modern Plastics.

MARKET DEVELOPMENT ENGINEER — Plastic Products — National producer of plastic and chemical products has an opening in its Commercial Development Dept. for an engineer who is experienced in the marketing of plastic products to industry. Please submit resume to Box 6854, Modern Plastics.

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SALES REPRESENTATIVE — Leading manufacturer of blow-molding and vacuum forming equipment for plastics and packaging industry has various territories open in Midwest, East, and Southeast. Exclusive territories available for aggressive men. Knowledge of plastics and experience in machine sales desirable. Include lines handled and territory now covered in reply. Box 6850, Modern Plastics.

SALESMAN — Potential sales manager Eastern Division for reprocesser of plastic compounds. Terrific opportunity for experienced, aggressive individual. Salary open. Chemsol, Incorporated, 74 Dod Street, Elizabeth 3, New Jersey.

EXPORT SALES — PLASTICS — A well-known chemical manufacturing company needs a technical sales representative for its plastics sales work overseas. Contacts are with fabricators, molders, distributors, sign makers, etc. in thermoplastic applications. College graduate, preferably in science or mechanical engineering, or with strong mechanical aptitudes. Will involve extensive travel out of United States. Must have some experience in thermoplastics and preferably overseas. Salary and expenses. Include full details in first letter. Box 6845, Modern Plastics.

FOREMAN for reprocesser of plastic compounds. Excellent opportunity for experienced man. Salary commensurate with amount of experience and responsibility man can assume. Chemsol, Incorporated, 74 Dod St., Elizabeth 3, N.J.

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WANTED — EXTRUSION EQUIPMENT SALES ENGINEER. Expansion program requires larger sales organization. Please submit all details to Essex Plastic Machinery Co., Inc., 58 Rantoul St., Beverly, Mass.

VICE-PRESIDENT WANTED—To take charge of sales for growing vinyl resin and compound plant. Other polymers coming. Opportunities like this come seldom. Send reply to Great American Plastics, Nashua, New Hampshire.

SALES REPRESENTATIVE — States of Ohio and Indiana to represent large Eastern manufacturer of plastic dry colorants. Previous experience in plastics field desirable. Reply in confidence. Box 6839, Modern Plastics.

ENGINEER — MECHANICAL — M.E. or equivalent wanted for medium size poly Extruder, Flexographic Printer and Converter. Excellent opportunity for experienced engineer to assume responsibility for manufacturing methods, special machine design, quality control, maintenance and repair. Salary and bonus commensurate with ability. Modern plant in Mass. Send complete resume, salary requirements, Box 6837, Modern Plastics.

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PLASTICS ENGINEERS — Immediate openings in our new Research and Technical Service Center for Engineers familiar with polymer evaluation. We require a Bachelor's Degree and 3 to 10 years experience in plastics processing, physical testing, and/or customer service, particularly in polyefins and polystyrene. Employment will offer challenging opportunities in applications research, technical service and resin investigation. Location in pleasant suburban Northern New Jersey. Please send detailed resume with salary history and requirements. All replies held in strictest confidence. Reply to Rexall Chemical Company, Dept. KK, P. O. Box 37, Paramus, New Jersey.

PLASTICS ENGINEER—Experienced in injection and compression, to take full responsibility for engineering and estimating departments. Salary open. Reply to: David Rome, Olympic Plastics Co., Inc., 3471 South LaCienega Blvd., Los Angeles 16, Calif.

APPLICATIONS ENGINEER—Degree in Chemical Engineering or Chemistry required. Prefer three years' experience in thermosetting and thermoplastic molding techniques and materials; plus, experience or interest in polyester and epoxy lay-up work, low cost plastic tooling, purchased laminates, and application of thermosetting resins. Work to include engineering development, consultation, in-plant manufacturing applications, and specification writing. Liberal company benefits. Relocation expenses paid. Send resume and salary requirements to Mr. J. F. Caldwell, Dept. 374, Westinghouse-Baltimore, P.O. Box 746, Baltimore 3, Maryland.

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Situations Wanted

PLASTIC MOLDING AND EXTRUSION CONSULTANT — Registered professional engineer offers the following consultant services: plastic mold and product design; plant time study and cost studies with cost saving recommendations; plant design, equipment recommendation and plant startup; metal parts vs. plastic parts cost studies. Box 6841, Modern Plastics.

SALES REPRESENTATIVE — Chemical Engineer with broad industrial experience and knowledge of plastics coupled with great enthusiasm for their potential wants manufacturer's agency, distributorship or sales position. Middle Gulf Coast area. To industrial, building materials, and wholesale consumer accounts. Ref., complete information on request. Box 6843, Modern Plastics.

PACKAGING ENGINEER with 10 years' experience in all phases of packaging and 3 years' experience in sales of plastic products desired to represent foam manufacturers and fabricators, blow molders, thermoformers and allied products in western and central New York State. Reply Box 6846, Modern Plastics.

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PRODUCTION MANAGER — 10 years' experience in plastic processing. Supervision of production, quality control, scheduling and plant maintenance. Thorough knowledge all thermoplastics. Seeks position with extrusion processing firm. Reply Box 6853, Modern Plastics.

PLASTICS ENGINEER, Overseas Chinese, with M.E. degree, trained in U.S.A. and West Germany, well experienced in maintenance and new molding process, seeks suitable position in any country. Address: P.O. Box 1423, Hongkong.

Business Opportunities

AMATEUR INVENTOR has a simple, unique consumer item, a natural for injection molding. Patent applied for. Some experts regard it favorably. Need connections for manufacture and sale on royalty basis, or might sell outright. Write James S. Whiton, 46 Myers Ave., Denville, N.J.

OFFERED FOR LICENSING OR SALE—Self-acting bottle closing device, as article for mass production by the plastic-processing industry. German and foreign patents applied for. Offered to interested parties in U.S.A. Enquiries requested in German language, to: Walter Haberle, Bad Vilbel (Hessen), Gronauer Weg 10, Germany.

FLOORING—Canadian manufacturer of exclusive flexible laminated vinyl floor covering seeks companies to sell and distribute our line. Product has won awards and widely accepted in Canada for domestic and marine applications. We would like to hear from firms who would be interested in taking on this line. Reply Box 6848, Modern Plastics.

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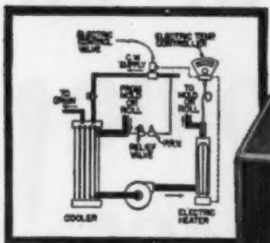

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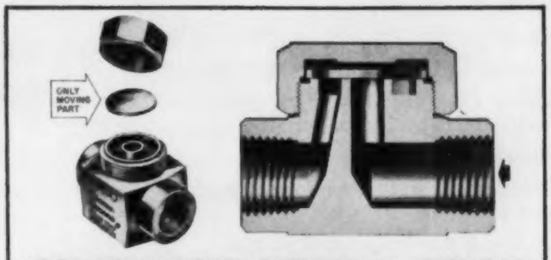

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